In this Issue: The Economic Type of Boat for Navigating Western Rivers.—The Beaver Bridge over the Ohio River.—The Design of Impulse-Wheel Buckets.—Roof of the 22d Regiment Armory, N. Y. City.—Engineering Material Prices.

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Buyers' Reference, Page 35

Alphabetical Index of Advertisers, Page 39

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TABLE OF CONTENTS.

LEADING ARTICLES:	Page.
Substructure of Cantilever Bridge over the Ohio River at Beaver, Pa., Pittsburgh & Lake Erie R. R. (illustrated)	509
The Most Economical Type of Boat for Operation on Western Rivers with an 8-Ft. Channel Depth (illustrated); Jno. M. Sweeney, M. Am. Soc. M. E..	512
Suggestions for a Rational Formula for Street Pavement Crowns (illustrated); G. B. Zahniser	516
The Status of the Engineering Profession in Great Britain	518
Advice Relative to Principles of Professional Practice and the Canons of Ethics	519
A Table of Lumber Weights	519
Framework of New 22d Regiment Armory, New York City; A Three-Hinged Arch Roof with Cantilever Skewback Supports (illustrated)	520
Some Points in the Design of Impulse-Wheel Buckets (illustrated); George M. Peck	522
The New Chief of Engineers, Colonel William H. Bixby (portrait)	524
A Long-Lived Bridge of Perishable Material (illustrated)	529
The Raldiris Bill for Licensing Engineers in New York	529
Sanitary Condition of Inlet Tunnel Water-Supplies Immediately after Completion (illustrated); John W. Alvord and Lewis I. Birdsall	530
A New Water Pressure Regulating Valve with Electrical Quick-Opening Attachment (illustrated)	531
Flood Losses in Missouri	531
An Emergency in the Life of a River (illustrated); Robert S. Taylor	532
Annual Meeting of the American Water-Works Association	535
An Odd-Shaped City Made Still Odder; Los Angeles, Cal. (illustrated); L. R. W. Allison	537
A Proposed Study of Earthquake Causes in California	537
The Decision of the U. S. Supreme Court in the Oberlin M. Carter Case	538
W. W. Snow (illustrated)	540
A Destructive Fire in a So-Called Fireproof Building	540
A New Engineering Building for Union College	540
Sewage Purification Results at Plainfield, N. J., 1909; Andrew J. Gavett	541
The Increase of Traffic and of Accidents on the Street Railways of New York City	541
EDITORIAL	525
The Revetment of the Banks of the Mississippi River—Waterproofing Wooden Bridge Floors to Protect against Decay—Conviction of Joseph M. Huston.	
The Status of Producer-Gas Power Plants in the United States	526
The Most Economical Type of Vessel for Navigating Western Rivers	527
LETTERS TO THE EDITOR	527
The Effects of Cooling a Boiler Furnace; A. Bement—An Effective Blast in a Quarry at Linnton Prison, Ore. (illustrated); J. C. Costello—Reinforcing Concrete with Structural Steel Shapes (illustrated); Joseph T. Maguire—The Accuracy of Simple Methods of Leveling and Plumbing Walls; W. M. P. Shelton—Criticisms on Customary Reinforced-Concrete Construction; Charles R. Steiner.	
ENGINEERING NEWS OF THE WEEK	542
PERSONALS	543
ENGINEERING SOCIETIES	544

Substructure of Cantilever Bridge Over the Ohio River at Beaver, Pa., Pittsburgh & Lake Erie R. R.

The Pittsburgh & Lake Erie R. R., running northerly from Pittsburg along the left bank of the Ohio River, crosses the river at the point where the latter bends to the west and south, at Beaver, Pa. The first bridge at this crossing was built in 1878, but later it was reconstructed, not wide enough to accommodate a double-track bridge, so that no part of the old work needed to be saved, and the span lengths, location, etc., of the old bridge did not limit the design. Moreover, there was opportunity to improve the alinement and increase the track facilities near the bridge by shifting the crossing some distance upstream. Accordingly the new bridge is about 300 ft. upstream of the old one. The spans of the new bridge were determined by the widths of the government bear-trap dams above and below, cantilever arms of 242 ft. each and a suspended span of 285 ft. The 320-ft. spans are the anchor arms of the structure. The 370-ft. span at the north end is an independent approach span. An outline drawing of the bridge is given in Fig. 1 herewith. The structure is of unusually heavy design, and on this account, as well as of its length, may be said to be the heaviest truss-bridge work yet built in this country.

The substructure of the Beaver Bridge was described in some detail recently by Mr. A. R.

View on Aug. 17, 1908, Showing Shafts for Dredging.

View on Nov. 9, 1908, Showing Air-Lock Wells in Stone-Faced Concrete Shaft of Pier.

TWO VIEWS OF NORTH ANCHORAGE PIER, PITTSBURGH & LAKE ERIE RY. BRIDGE OVER OHIO RIVER AT BEAVER, PA.

again as a single-track structure. The existing bridge is now taxed about to its limit by the train loading, and its single track (or rather two tracks gauntleted, to eliminate the complications of switching) is insufficient to carry the traffic of the road. Several years ago, therefore, it was decided to build a new double-track bridge adjoining the old structure.

The span arrangement of the old bridge is not the most favorable as concerns river navigation, and it was desirable to use better span lengths in the new bridge. It happened that the old piers, being built for a single-track bridge, were which dams are constructed with a clear channel width of 700 ft.; for the same clear channel width at right angles, the center to center length of channel span on the axis of the bridge as decided upon (slightly skew to the channel) was 769 ft., and this length of span was adopted. Side spans of 320 ft. each and an approach span on the north end of 370 ft., gave a suitable location for abutments.

The bridge is of the strict three-span cantilever type, and is quite similar in its general outlines to the Monongahela Bridge of the Wabash R. R. at Pittsburgh. The channel span is divided into

Raymer, Assistant Chief Engineer of the Pittsburgh & Lake Erie R. R. Co., in a paper read before the Structural Section of the Engineers' Society of Western Pennsylvania. From this paper we abstract the following particulars.

RIVER AND SOIL.—The Ohio River at the site of the bridge has a maximum rise of over 46 ft. above low water. The normal or pool-full stage is 7.1 ft. above low water. The depth at low water is quite shallow.

The river bottom soil is chiefly gravel. To make certain of its character and depth, diamond drill borings were put down, two on the site of

each pier and abutment. These showed that a water-bearing gravel continues all the way to rock, rock being about 30 ft. below low water. Both sandstone and shale were found. The general surface of the rock was practically level.

All piers and abutments are of concrete, with embedded reinforcing bars at some points, and a facing of Beaver Valley sandstone on the visible faces. The bridge seats are not of stone, however, as will be described later.

SOUTH ABUTMENT.—The south abutment not only carries the varying loads or uplifts of the anchor arm, but also serves as retaining wall to a 66-ft. embankment. If this pier were to be carried down to rock, its total height to under the extreme conditions of this case. The total vertical load on the foundation is 13,400 tons, comprising 6,570 tons masonry load, 1,800 tons superstructure load and 5,030 tons earth load. The pressures per square foot at back and front of base, under different conditions of loading, are given by Mr. Raymer as follows:

FOUNDATION PRESSURES, SOUTH ABUTMENT.

	Tons per sq. ft.	
	Back.	Front.
Masonry unloaded, no fills	3.1	1.3
Masonry unloaded, fill at back	3.5	3.5
Masonry, bridge load, fill at back	3.5	3.5
Masonry, bridge load, fill back and front	4.2	4.2
Masonry, bridge load, fill back, front and ends	4.4	4.4
Masonry, bridge uplift and all fills	1.9	4.1

concrete later. The design of the end shoes is such as to maintain a uniform tension in the anchorage eyebars, this tension being that which occurs under maximum uplift conditions; and this is one of the numerous notable details of the bridge.* When the bridge was near its closure point at the center, with the erection traveler at its outer end, producing maximum uplift at the anchorages, wedges provided in the shoes between the upper anchor pin and the shoe baseplate were forced in tight, maintaining the eyebars in their stretched condition. Under all conditions of reduced uplift or even resultant downward load, at the anchorages, the tension of the eyebars is absorbed in part or in whole by

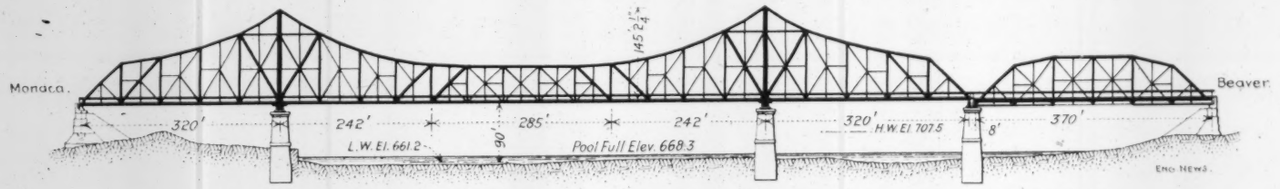


FIG. 1. OUTLINE OF NEW PITTSBURGH & LAKE ERIE RY. BRIDGE OVER OHIO RIVER AT BEAVER, PA.

rail level would be about 110 ft., which seemed out of the question, in view of the heavy lateral earth pressure to be resisted by it. The soil overlying rock was quite firm, and was judged easily able to take moderate foundation pressures, at any rate if assisted by piling. Therefore the decision was reached to found the abutment on a piled foundation a little below ground level. Since this was still some distance above the water plane, concrete piles were planned for. However, when excavations were made the character of the soil was found to be so good that the pressures of four to five tons per square foot which would occur under the base of the abutment could be safely carried by the soil direct.

As this table shows, the design was so worked out that under full dead-load as well as when any one of the earth fills is removed, the foundation reaction would be central to the area of the base, in order to give maximum uniformity of settlement. The slope of the earth faces of the wall is adjusted to accomplish this. It is stated that while the embankment fills were being made the abutment settled ½ in. vertically with no horizontal movement.

The means for receiving the anchorage eyebars of the bridge in the abutment are worth noting.

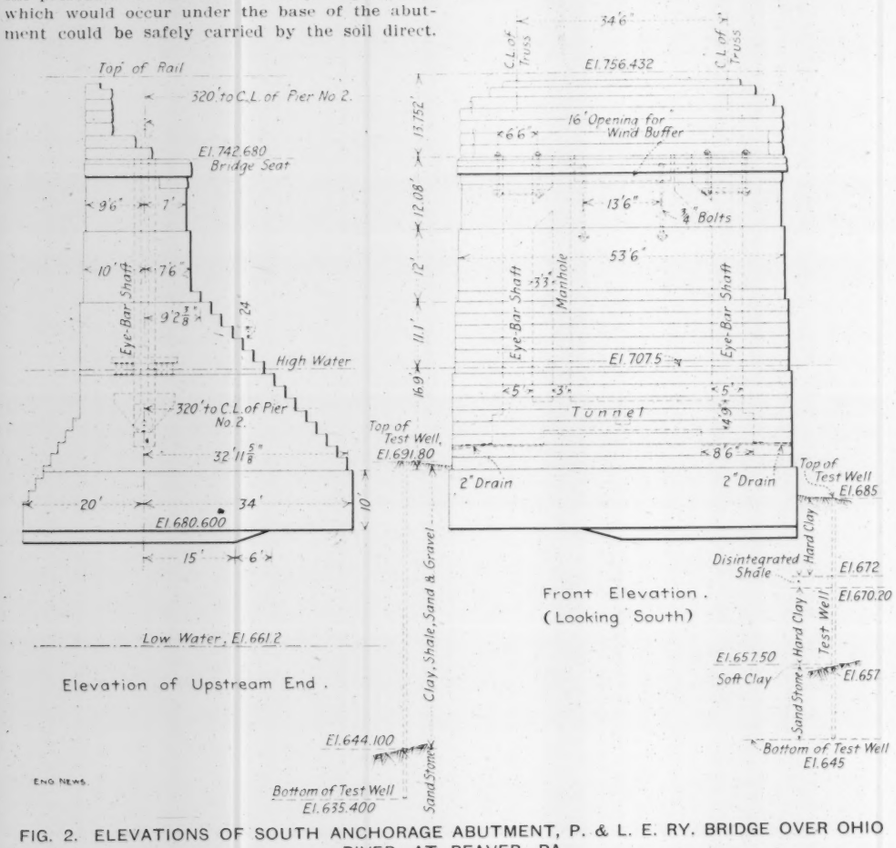


FIG. 2. ELEVATIONS OF SOUTH ANCHORAGE ABUTMENT, P. & L. E. RY. BRIDGE OVER OHIO RIVER, AT BEAVER, PA.

In consequence, the plan of using piles was abandoned, and the abutment was constructed directly on the soil.

The principal elevations of the abutment, Fig. 2, show how the joint service requirements of pier, anchorage and retaining wall were met Two vertical shafts were cored out in the concrete, connected below by a horizontal passage in which the anchorage girders were set. A third vertical shaft going down to the girder seat was provided as a manhole for use in the work of filling the shafts and passages with the masonry of the abutment. This arrangement eliminates all changes of length in the eyebars after the bridge is once completed, and the space around the eyebars can therefore by filled solid without danger that elastic changes of length of the eyebars will cause a separation between eyebars and concrete and so give opportunity for entrance of water and rusting. The outline sketch of the end shoe in position on the pier top, Fig. 3, indicates in a general way the wedge arrangement.

RIVER PIERS.—The channel piers and the north anchorage pier were founded on rock under air pressure. A peculiar feature of their construction, however, was that the major part of the sinking was done by open dredging, and only after the pier structure was practically grounded on the rock was a deck built and air applied in order to clear the foundation surface and seal it with concrete. The gravel was so open and permeable that it was impossible to do this work in the dry without recourse to air. The rock surface had sufficient unevenness (and probably loose or rotten rock on top) to make it desirable that the bedding of concrete on the rock be done with proper assurance of getting a sound, thorough contact.

The open dredging method was adopted as the result of competitive bids, the call for which specified that the concrete laying must be done in the dry, using compressed air for fitting the pier to the rock and sealing with concrete (without specifying the method to be used for the rest of the sinking). The bids received were with one exception for regular pneumatic caisson work; the one bid was for open dredging through shafts in the concrete pier bases, employing compressed air work for only the fitting and sealing operations.

The body of the piers being of concrete, the dredging method was applicable with a minimum of trouble, as the entire pier below low water could be treated as a concrete cylinder with relatively thin walls and large shafts. In the execution of the work two cross walls were constructed across the hollow interior of the pier cylinder, dividing the latter into three chambers or shafts. The outer walls were about 7 ft. thick and their bottom edges were tapered off in steps on the inside to an edge faced with an 8 × 8-in. angle serving as cutting-edge. Bolt anchors extended upward from this angle-iron into the concrete near the inner and outer surfaces. The walls of the cylinder contained some vertical reinforcing rods as a safeguard against possible tensile rupture in the last stages of the sinking, due to excessive friction between cylinder and soil.

Orange peel dredges were used for excavating through the three shafts. No difficulty was experienced in controlling the verticality of the structure while sinking, as it readily followed the

*This will be treated more fully at a later date, when we shall describe the superstructure.

uidance given by dredging deeper at one end r the other.

The final locations of the three river piers ıried from their intended location by an aver- ge amount of 0.12 ft. longitudinal of the bridge nd 0.56 ft. transverse to the bridge.

The soundings having shown that the rock ıt the site of the piers was not quite level, the

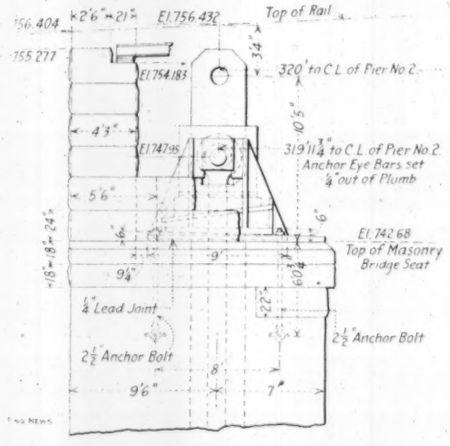


Fig. 3. Top of South Abutment, and Position of Wedge Shoe of Anchor Arm.

caissons were built with the plane of the bottom edge sloped to fit the rock. However, when the piers were grounded (cutting-edge about 16 in. above rock), the water flowed under the cutting-edge freely enough to make it difficult even to pump the water down to a level 10 or 12 ft. above the edge, where forms had to be set for a concrete deck. The walls themselves were watertight, proving the inflow to come under the cutting edge. The deck completed, air pressure was put on, the remaining material over the rock excavated, the caissons sunk through the remaining small depth to a bearing on rock, the rock surface cleaned off and the whole structure filled with concrete.

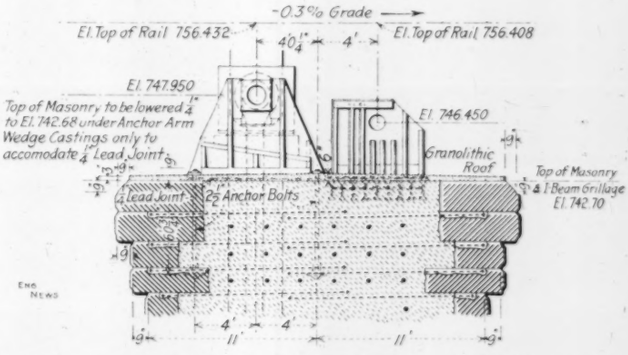
The total load on the foundation of each of the channel piers is about 32,000 tons, of which about 12,600 tons is superstructure load. The pressure per square foot on the rock is about 8 tons from masonry and 5 tons from superstructure, or 13 tons total.

The shoes of the main posts resting on the two channel piers are large steel castings with a circular seat for segmental rollers to form a virtual hinge joint—another of the novel features of the superstructure. The bottom face of the casting is 150 sq. ft. in area, so that the post load of 6,000 tons gives a pressure of 40 tons per sq. ft. To distribute this over the pier masonry at a more moderate pressure, an I-beam grillage is set under the shoe. This has an area of 240 sq. ft., making the pressure on the masonry about 25 tons per sq. ft. In the upper 50 ft. of pier below the grillage, 1¼-in. rods were placed in alternate layers lengthwise and crosswise in the concrete to assist in distributing the shoe pressure over the full cross-section of the pier.

The concrete forming the body of the piers is a 1:3:5 gravel mixture, used soft enough to puddle. This applies also to the abutments.

The top surface of the piers is not finished with the customary stone capping. The shoe grillage is set upon and surrounded by 1:2:4 concrete (as against 1:3:5 in the body of the piers). The stone outer surfacing of the piers forms only an outer ring on the top face. It was necessary, therefore, to provide a protective surface coat over the pier top. For this purpose a granolithic pavement or roof about 3 ins. thick was placed over the entire top surface, out to the inner line of the coping, and carefully finished against the edges of the shoe castings to make a water-tight protection. The same kind of top finish was used on the abutments.

The north anchor pier has the same provisions for the anchorage eyebars as the south abutment. The top of the pier carries also the end shoes of the approach span. The relative positions of the two sets of shoes are shown in the sketch, Fig. 4.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25 Anchor Bolts
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4'
11'

FIG. 4. TOP OF PIER 4 (NORTH ANCHORAGE), SHOWING SHOES OF ANCHOR SPAN AND APPROACH SPAN IN PLACE.

NORTH ABUTMENT.—The construction of the north abutment involved substantially the same problems as the south abutment, except that it carries the fixed reaction of the approach span instead of the reversible reaction of the anchor arm. However, it was not thought safe at this abutment to dispense with piling, the soil not being considered firm enough, creating the risk of excessive compression and settlement. Moreover, the conditions were somewhat different from those at the south abutment inasmuch as the rock was considerably deeper, being about 130 ft. below rail level, or 68 ft. below ground surface. The foundation was therefore designed with piles.

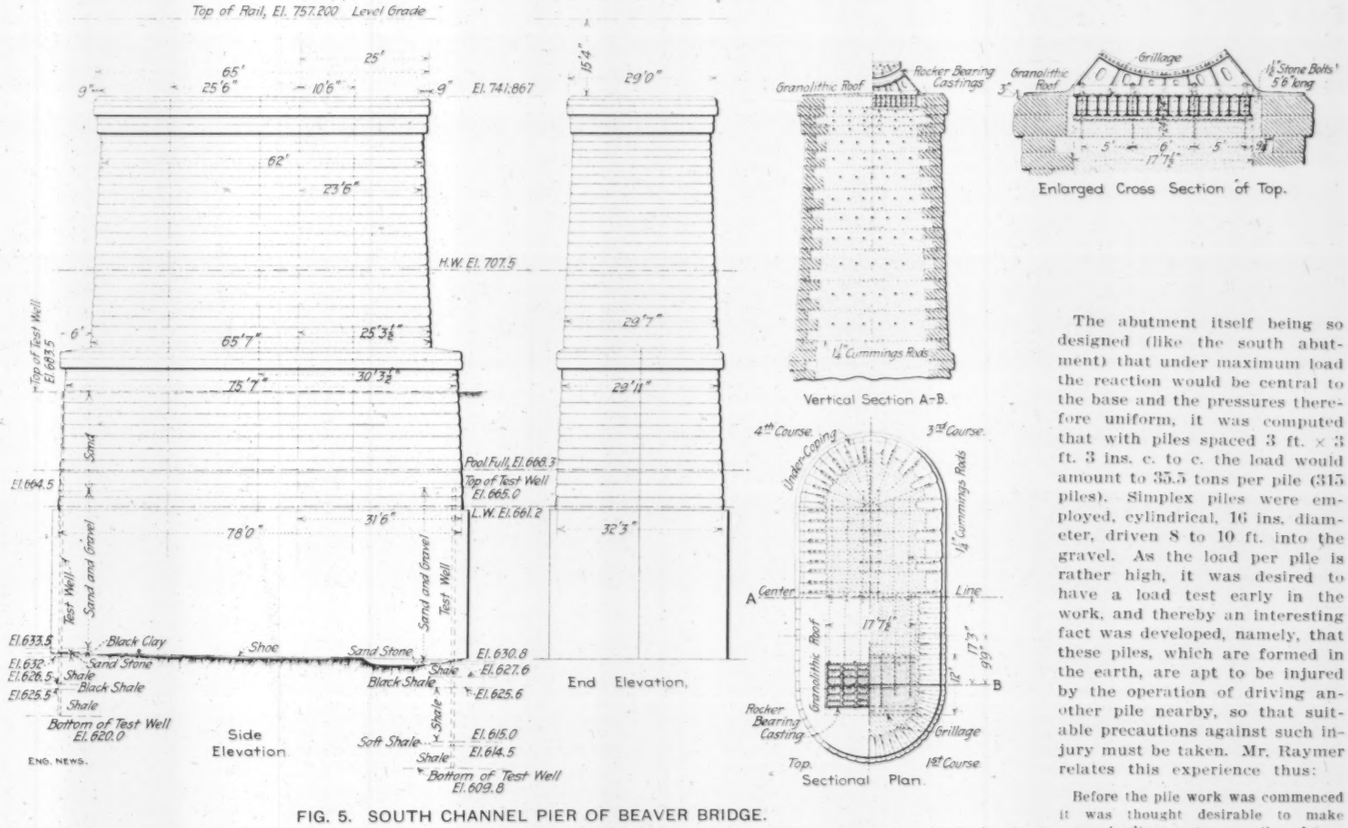

FIG. 5. SOUTH CHANNEL PIER OF BEAVER BRIDGE.

The cylindrical roller-bearing shoe is a steel casting. It carries the foot of the main post of the cantilever, forming a hinge bearing.)

The abutment itself being so designed (like the south abutment) that under maximum load the reaction would be central to the base and the pressures therefore uniform, it was computed that with piles spaced 3 ft. × 3 ft. 3 ins. c. to c. the load would amount to 35.5 tons per pile (315 piles). Simplex piles were employed, cylindrical, 16 ins. diameter, driven 8 to 10 ft. into the gravel. As the load per pile is rather high, it was desired to have a load test early in the work, and thereby an interesting fact was developed, namely, that these piles, which are formed in the earth, are apt to be injured by the operation of driving another pile nearby, so that suitable precautions against such injury must be taken. Mr. Raymer relates this experience thus:

Before the pile work was commenced it was thought desirable to make some loading tests on piles driven

similarly to those in the proposed foundation work. The first test consisted of a pile driven with four others around it spaced as in the foundation work, the four being driven while this test pile was still soft. The second test differed from the first only by allowing the test pile to partially set before the four piles around it were driven. The working conditions on a large foundation are such that the second test more nearly represents the actual conditions than the first. After both test piles were allowed 30 days to set, the first pile supported a load of 60 tons for 72 hrs., with 9/64-in. of settlement, which settlement it recovered almost wholly after the load was removed, while in the other case the results were, as was to be expected, not good enough for approval.

To meet the difficulty developed by the conditions of the second test, which is simply recognizing the well-known limitations of concrete and applicable to all kinds of concrete piles formed in place, the following specifications were used, it is believed for the first time on such work:

The setting of the concrete in any pile must not under any consideration be disturbed by driving another pile or piles within a radius less than 9 ft. center to center from it, after a minimum interval of 3 hrs. or before the expiration of seven days from the time the concrete was mixed with water for that pile. The contractor may, however, at his own option drive pile forms within the 9-ft. radius to a depth not more than 3 ft. from the total estimated penetration, inside of the 3-hr. limit; and then after the 3-hr. limit and before the expiration of the seven-day limit complete the driving and filling of these forms.

This specification was strictly observed; the piles were driven in rows across the foundation in the following order: Rows Nos. 1, 4, 7, 11, 15; then Nos. 2, 5, 8, 12; and 3, 6, 9, 13. After the piles were completed the earth was excavated a couple of feet below the cut-off line, and the concrete was filled in the usual way around and over the pile heads.

It is noted that the construction of the fill behind this abutment caused a vertical settlement of 1¼ ins., which is over twice as great as the settlement of the south abutment. In both cases, however, the settlement was uniform and there was no lateral motion.

The construction of these piers and abutments was begun in the Spring of 1908 just after high water, and the work was all completed by December, 1908 (except that the upper part of two of the river piers remained uncompleted until after the 1909 Spring floods). This is an excellent record of speed for work of such magnitude, and this fact no doubt can be credited in large part to the method of sinking adopted. Erection of the superstructure was begun in 1909, and is now practically completed. The piers and abutments were built by the Dravo Contracting Co., of Pittsburg, Pa. The superstructure is being constructed by the McClintic-Marshall Construction Co., of Pittsburg. Mr. J. A. Atwood is Chief Engineer of the Pittsburgh & Lake Erie R. R. Co.; Mr. A. R. Raymer, Assistant Chief Engineer.

The Most Economical Type of Boat for Operation on Western Rivers with an 8-Ft. Channel Depth.

By JOHN M. SWEENEY,* M. Am. Soc. M. E.

The most economical type of boat for freight transportation on the rivers of the Western United States, is the type which will do its work at the smallest total cost. Many items contribute to this total cost. The result is so affected by local conditions that what is the most economical design of boat for one section of a river may not be the most economical for another section. While it is impossible to designate any complete plan as most economical under all conditions, there is one basic requirement of boat design for these rivers, which has been arrived at from the experience of the past ninety years in their steam navigation. This has established the stern paddle wheel as the type of boat best adapted to these rivers, to secure the most economical results. It is the combination of the stern wheel, and the rudders placed between the wheel and the stern of the boat, which gives to this type of boat its commanding place. In Mr. Thos. P. Roberts' article in Engineering News of Feb. 17, 1910, some of the advantages of the stern-wheel construction were pointed out as applied to tow handling; but there are many additional advantages with respect to the up-stream work of the tow-boat, and with respect to the operation of the so-called packet boat in all classes of work.

The men foremost in the gradual working out of the arrangement of rudders establishing the stern-wheel boat as the best type, were not fully aware of all the advantages, nor the reasons for them; therefore it is hardly a surprise that many prominent engineers fail at first glance, or indeed at second glance, to discover any virtue in the stern-wheel boat.

In 1888 a paper was contributed to the proceedings of the American Society of Mechanical Engineers, at the Nashville Meeting, which was the first to put on permanent record a detailed technical account of the steamboats used on western rivers. The discussion on this paper at that meeting illustrates the hasty way in which the stern-wheel is judged. One prominent engineer brushed the entire propelling plant overboard in a breath, and substituted a number of Westinghouse engines and propeller wheels across the stern, to his entire satisfaction; in blissful ignorance of the fact that in a day's work with usual landings the stern-wheel boat would accomplish easily what with his proposed construction would be impossible.

The discussion on this paper also brought out the usual smart remarks about the "high" steam pressure employed on these boats, the use of hams for fuel, and of course the "nigger" on the safety valve lever! Perhaps some day proper credit will be given to the Western boat designer and when it is realized how far he was in advance of the profession in the use of high pressure steam, the funny man's remarks of 20 years ago will be properly appreciated.

There is an authentic tale of a manufacturer of marine boilers from the classic Chesapeake, who about this date took passage on an Ohio river boat. Discovering 140 lbs. pressure on the steam gage before the boat had left her dock, he at once cancelled his passage!

EARLY DESIGNS.—The first boats used on Western rivers had side wheels and a single engine with stiff shaft; but this was soon altered so that either or both wheels could be disconnected by clutch from the engine, making it possible to operate either wheel backward or forward, while the opposite wheel was idle. This was a great advantage in the ability to make quicker landings. Indeed the early steamboats avoided landing wherever possible, using a yawl for transfer of passengers and small freight from the boat to the shore. When compelled to come to the bank, they cast anchor in the stream, sent a line ashore by the yawl which was secured there and then hauled the boat to the bank on that line, paying out on the anchor cable. This operation was reversed when the boat was started. This no doubt brought about the practice of turning the boats head up-stream in making down-stream landings.

The next change was the use of two independent engines, one for each side-wheel; with this equipment the wheels might be turned in opposite directions at the same time. With this alteration the highest effectiveness of the side wheel boat for western rivers was reached, and this type of boat continued in use without further development until they were finally (with a few isolated exceptions) displaced by the stern-wheel boats.

That the stern wheel did not come more quickly into general use was due to the slowness with which improvements in rudder construction were adopted. As late as 1882, a boat was in service on the Ohio River which frequently was backed ten or twelve miles down stream because of inability to turn herself when an up-stream wind was blowing. Sometime between 1830 and 1840, trial was made of two wheels at the stern capable of independent operation in opposite directions; but this was not productive of betterment, nor was a similar attempt made many years later.

DESIGN OF RUDDERS.—The form and shape of stern construction established also the shape and attachment of the rudders, and for a long

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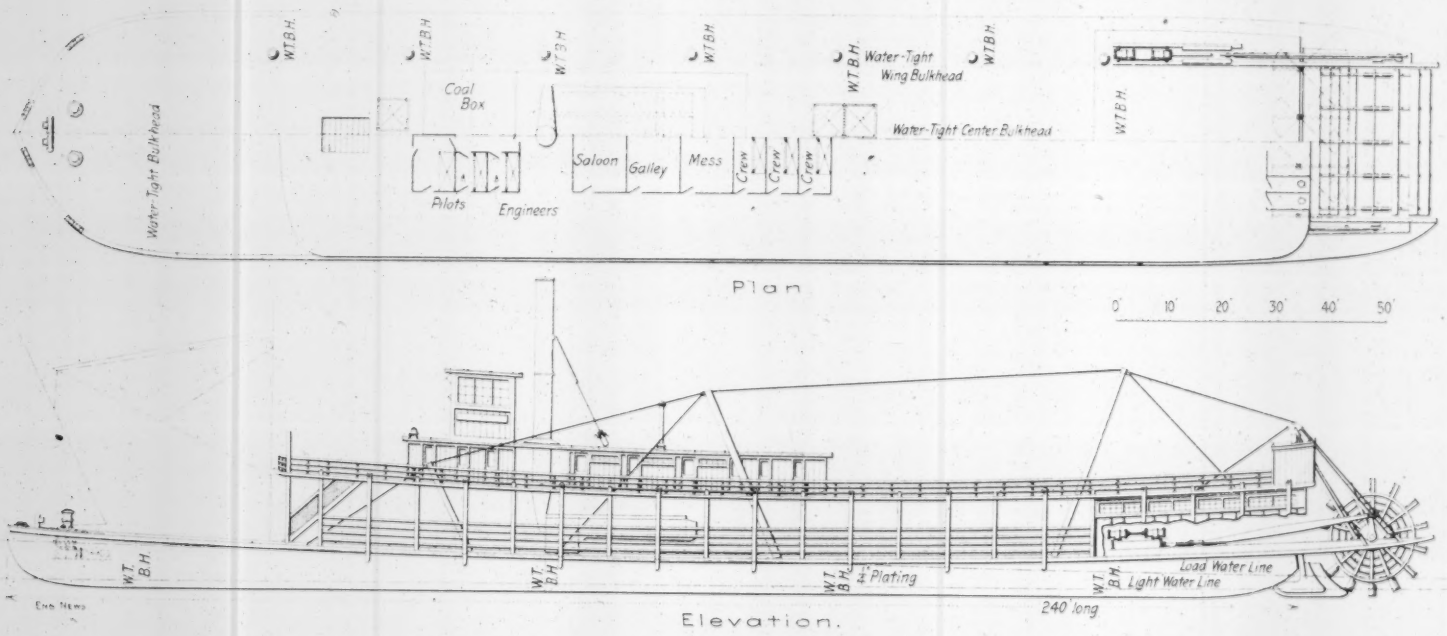

GENERAL PLAN AND ELEVATION OF STERN WHEEL PACKET BOAT FOR OPERATION ON THE MISSOURI RIVER.

time these remained without change except as to various dimensions and various number of rudders in proportion to the beam of the boat. Figs. 1 and 2 illustrate the early plans for three rudders.

Here each rudder was attached to a skeg which was fixed to the hull of the boat. The first departure from this method was the addition of two rudders placed between the outside rudders and the center rudder, say on the lines A-A. These rudders had no corresponding skeg, and as they had blades extending both fore and aft of the pintle, they were called balanced rudders to distinguish them from the ordinary construction. However, they were better known as fly rudders, to distinguish them later from the regular balanced rudder to the stock of which the tiller attaches. Fig. 3 shows the arrangement of fly rudders.

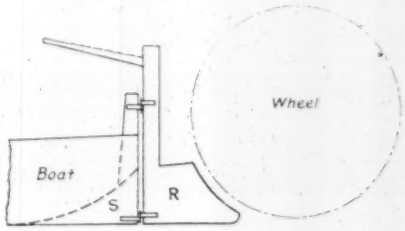

Fig. 1.

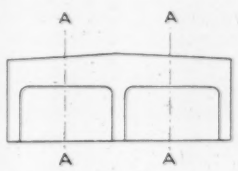

Fig. 2.

These fly rudders were coupled to operate in unison with the other rudders and by the same steering wheel. This departure from the established practice soon resulted in the discarding of the skeg attached to the hull for the middle rudder, the substitution of a balanced rudder for the former single rudder and the abandonment of the fly rudder as well. It has only just become clear while writing these notes, that what these people really did was to detach the skeg from the hull of the boat, and attach it to the rudder, so that it (the skeg) followed any change in rudder position. The far reaching effect of this construction when carried to its final application to all the rudders is the factor most responsible today for the commanding position which the stern-wheel type of boat holds for river navigation.

For a considerable time, although no further great change occurred in design, some minor variations were made. The outside or skeg rudders were moved inboard from the extreme outside of the hull in order to bring them in front of the paddle wheel. This change was beneficial because (and we have now come to the kernel) the effectiveness of the rudder when the wheel is backing is the one thing for which sacrifices can be wisely made. So far as the control of the boat when moving forward is concerned, very little rudder effort comparatively is required. It is easily appreciated that no rudder can be effective unless a current of water impinges against the rudder blade, and that the resultant force deflects the stern or rudder end of the boat to one side or

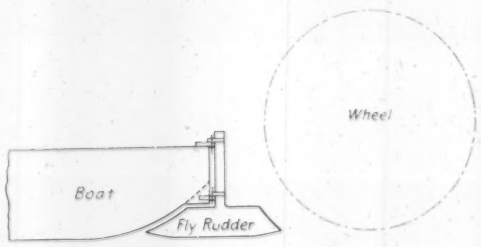

Fig. 3.

the other, according to the rudder angle. Now with the stern-wheel boat, when it is desired to quickly change the direction of a large tow, it is only necessary to position the rudder and back the wheel in order to throw the entire volume of water moved by the wheel, as an immediate and powerful current against the rudders. In the original skeg construction, however, this current could not be applied with effective results, because of the counter currents which were created (see Fig. 4).

Here, as will be noted, the wheel forced a great volume of water into the pockets between the skegs, which piled up and countered the first effective attack of the current from the wheel. It is apparent that the removal of the center skeg from the hull, and its attachment to the rudder as an extension of the blade, produced much greater effect than one would expect to follow the mere substitution of a balanced rudder in place of an ordinary rudder. It was only a further step to entirely discard any skeg attached to the hull, and to make all the rudders on the stern-wheel boat balanced. This change however came somewhat slowly, and had some reversals, due to the use of too much area in the forward part of the rudder blade, so that when the boat was moving forward, the stronger action on the forward part of the blade made the rudders run to "hard down" position, unless constantly held. That difficulty, however, has now been entirely overcome, and the largest towboat on the rivers transports 60,000 tons, practically in one package for 1,500 miles, handling them with four such rudders.

The detail operation of this rudder arrangement is unknown to the general engineer critic, native or foreign. Nor does the ability to apply Kutter's formula or to secure an election to Congress qualify one to pass intelligently on the fitness of the American type of boat for the work they may witness it doing, or to judge what a boat on foreign waters is doing, or what it might be able to do if placed on our rivers.

The stern-wheel boat holds its supremacy in other situations as well as in handling tows. The packet boat making many landings, has abolished the old methods. Now she can connect with the shore with confidence, back away from it and be gone while the anchor would be yet in the mud; but better still she can make her down-stream landings by backing in, and so keep her head down-stream all the time.

At no time or place has the stern wheel American Western river boat failed to prove the best type for work on any river. Recently a report was made on the performance of one of these boats on the River Nile. This boat was built on the upper Ohio River, shipped in pieces and erected on the upper Nile. The report made by the engineer of the purchaser—an English company—congratulates the company on the possession of a boat enabling them to carry on transportation in a manner so much more effective and economical than their competitors. The report of the performance of this boat is a wonderful sermon on the fitness of the type.

OTHER QUESTIONS.—Of course many questions are propounded apart from the question of motive power. What are the best proportions of hull and what is the best material for construction? A criticism is often heard of the use of wood and an advocacy of steel. What is the best and most economic type of steam engine? Simple non-condensing, compound, or compound condensing? What is the best type of boiler? Why not use water tube boilers? What is the best type of wheel, radial or feathering? Why not use a screw propeller? If no other way can be found half submerge it and put it in a tunnel. Such questions are constantly being brought up and their propounders present the answers as if they had discovered a new way to increase profits of boating on these rivers.

What has gone before is poorly expressed if it has not fully answered the last question. Quite as intelligent an application of the screw propeller method as could be worked out has been made in two boats for the government's use on the Kanawha River. They are good exponents of the propeller boat for shallow draft; but as yet no individual has adopted them as preferable in any manner to the stern-wheel type of boat.

In the second of these government boats an attempt was made to secure some of the stern wheel effect by introducing a rudder forward of the propeller as well as aft of it, but with indifferent success. The stern-wheel boat has so much greater steering and handling ability when close on the bottom than any other type, that all other devices lose in comparison on that point alone.

NON-CONDENSING ENGINES.—The simple non-condensing engine needs no apology for past performance. Its greatest defect is in the high percentage of clearance and attendant waste of steam. In the wooden boat, with the weight of the paddle wheel and shaft carried on wood beams supported at one end and loaded at the other, frequent deflections of the beams occur, and attempts to secure a small piston clearance results in the pistons striking the heads of the cylinders. The form of valve gear which increased the steam loss due to large clearance, was influenced by this same deflection, and determined a form of valve-gear which permitted deflection of the supporting beams without appreciable change in the timing of the valve movement. In recent years the use of stiffer steel beams, even on wooden boats, makes possible a very appreciable lessening of the clearance allowance. Yet even at its worst the accomplishment of these old engines was not so bad.

The following table records a test made by a party from Stevens Institute some years ago on one of our Western river boats and on an Eastern passenger paddle-wheel boat with compound-condensing engines of approximately equivalent horse power.

	Western river-boat non-condensing.	Eastern river-boat compound condensing.
Horsepower per sq. ft. of grate.....	11	10
Coal consumption per hr. per sq. ft. of grate	60	40
Horsepower per ton of weight of machinery	13	7
Sq. ft. boiler heating surface to one HP.	2.7	2.75
Pounds of coal per hour per HP.....	5.56	3.75

Considering that the cost of the anthracite coal used on the Eastern boat is three or four times that of the bituminous slack used on the Western boat, the incentive for saving coal while increasing the weight of the machinery outfit is slight.

BOILER DESIGN.—In connection with the above record it is not out of place to call attention to the performance of the much abused river steamboat boiler. The most valuable feature of this type of boiler is its storage capacity, and this characteristic is alone sufficient to give it first choice over any form of boiler not possessing it. It is a usual experience that on a tow

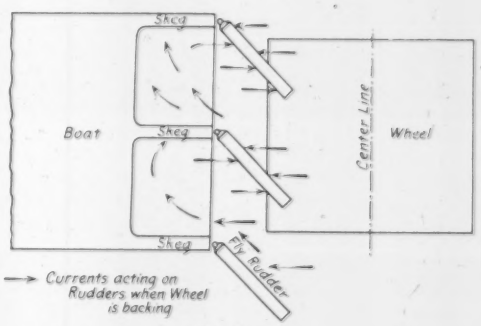

Fig. 4.

boat driving a heavy tow up-stream and carrying say 180 lbs. of steam, the oncoming watch of firemen will clean the furnace of clinkers entirely across with no observable drop in the steam gage pressure. The very excellent form of grate and furnace accounts for part of the boiler's success. Noting from the above test that this type of boiler is producing one horsepower to each 2.7 sq. ft. of heating surface, that these boilers give continuous operation for long periods of years with small expense and trouble, that they are easily and quickly cleaned, have few plates or joints to make or remove, and are easily repaired, it is small wonder that a more efficient boiler, considering every item is hard to find.

FUEL ECONOMY.—It is a favorite but hasty assumption of the usual critic of the river boat that the low cost of down-stream transportation is due to the assistance of the current. The most reliable data on this point show that say 8,000 tons are carried eight miles per hour down stream, and that the current is three miles per hour. This is equivalent to 8,000 tons carried five miles through still water on a fuel consumption of 900 lbs. We therefore obtain 40,000 ton-miles of transportation at a cost for fuel of about 50 cts.

An appreciable fuel economy would follow from an increase of engine piston speed, and many attempts have been made to secure it. Engines have been geared to the paddle wheel through cog wheels, friction wheels, belts, chains, and like devices, but in all these cases the disadvantages have been found to be greater than the advantages.

FEATHERING PADDLE WHEEL.—The use of a feathering wheel would be of great advantage in securing an increase of piston speed, because a smaller diameter of wheel could be employed, and its revolutions could be largely increased over the wheel with radial paddles. Besides a great economy could be secured in the lessened oblique action of the paddles. But no one who has had experience with all the conditions to be met in river navigation such as silt, ice, drift, shore landings and consequent wear and breakage, would attempt the use of feathering wheels without a full appreciation that it could be only a costly experiment, and that to give a service approaching regularity and avoid large expense bills, he would have to return to the radial paddle-wheel.

The Western rivers have not escaped new experiments in wheel improvements so called, and often odd devices have been substituted for the wheel itself, with the invariable result that the invention came to grief. There is, however, a very interesting question as to the preferable number of paddles in a radial wheel in proportion to its diameter to produce the best propelling result. Every builder and designer is a law unto himself, many adopt an increased number of paddles to lessen vibration; but for efficient propulsion alone the proper number of paddles is a debatable subject.

The writer once asked Mr. John W. Nystrom this question: "Suppose a customer asked me to build a stern wheel tow boat of given dimensions, to run long distances without a stop. Suppose another customer called for a stern-wheel packet boat of exactly the same dimensions and power—to make frequent landings. How would you determine the number of paddles to place in the wheel of the tow boat and in the packet boat?" His reply was "I would look around and see what others had."

Since the function of the wheel is to drive a current of water through the surrounding water, the resistance of which current to being set in motion is the measure of the propulsive effect, there should not be so many paddles that a following paddle would act upon water set in motion by the preceding paddle to any great extent. Where such action occurs much improvement has followed from a reduction in the number of paddles.

STERN WHEEL RIVER STEAMERS ON THE COLUMBIA.—The Columbia and Willamette Rivers on the Pacific coast have developed a stern-wheel boat of slightly different design from those used on the Mississippi and its tributaries. The hulls have finer lines, and the draft of the empty boat is greater. Larger engines are used in proportion to the length and beam of the hull. These boats stow no freight in the hold but carry deck loads only. Here there would be more justification for the use of compounding-condensing machinery. Firebox locomotive type boilers are adopted extensively and to avoid use of the water direct from the river in the boilers, the boats are fitted with water tanks, and a supply of fresh water in many cases is taken from the street mains of a town or city. These boats use balanced rudders but usually not more than two, and the blade area of the rudders is much smaller than on the Mississippi River boats.

In some of the more recent boats on these Pacific slope rivers, the cylinder beams are extended beyond the after-side of the wheel, to permit the attachment of a thwartship timber to their ends, and on this timber is attached an additional rudder, which is thus placed behind the wheel. It is said to be of great assistance in working ahead from a landing. At that time the wheel draws the water from between the shore side of the hull and the shore, so that the greater water pressure on the outside tends to force the boat to the shore. No doubt this extra rudder, which is in the active current made by the wheel when in forward motion, is of considerable assistance. It has not been proposed for the Western rivers, where the larger rudder area used would not seem to demand it.

TERMINALS.—One great item of cost in the operation of the river boat is that of loading and unloading. This does not of course apply to the loading of coal where the coal falls by gravity from a bin into the barge; but for miscellaneous freights the method of getting loads onto and off the boats is crude and costly; yet the diversified conditions which have to be satisfied make it exceedingly questionable whether the creation of comprehensive freight handling machinery at terminals would remove all of the trouble, or save much expense in the end.

Great interest and some discussion has followed the announcement of a plan, not detailed at all, to provide terminal loading and unloading stations and labor-saving machinery for handling freights at river landings. Since little in this direction has been practically accomplished, theories are quite likely to be formed without due attention to some of the conditions to be met which are probably likely to interfere with smooth and successful operation.

Certainly one part of the announced plan is wrong! The dimensions of the barge to be used, 350 ft. long and 50 ft. beam. It should be self-evident that four barges each 25 ft. beam and 175 ft. long would be much more economical, capable of easier placing for loading or unloading, and of protective treatment in case of grounding or accident. It is a great error also to assume that a compartment barge to be loaded in the hold, with numerous openings through the deck and no structure above the deck is the most efficient form of freight carrier. In handling rails, brick, pig metal or like materials not requiring cover, the best place for their stowage is on the deck itself, which can be kept with few openings to preserve stiffness of the hull structure. For such freights as require cover, there is no form so economical as the light cargo box, built on the deck of the barge.

Stowage in the hold should be adopted only for cargo which cannot be carried on deck and load the barge to its capacity.

In the most prosperous days of bulk grain shipments by water between St. Louis and New Orleans by the Mississippi Valley Co. barges (not the Anchor line as Mr. Roberts states, the Anchor line operated a line of side-wheel boats for freight and passenger service), the grain was loaded upon the boats from elevators, and it is hard to surmise how the loading and unloading facilities used at that time could be greatly improved upon. Throughout the Mississippi routes, with the exception of some attempts at Memphis, no special appliances were used for handling merchandise freight, but freight was hauled by teams to wharf boats, (floating storage houses) at many points.

In the brick industries of the Ohio Valley where large shipments are made by barge, many inclined railways are used, the loaded car descending bringing back the empty car. The brick, loaded on barrows, are lowered to the barge, and wheeled in the barrow to the point of stowage on the barge deck. The barge is so placed relative to the incline as to avoid long wheeling. Many of the blast furnaces in the Ohio Valley received large supplies of iron ore by barge, and provided inclined railways for unloading.

For miscellaneous shipments the method which might be called the universal one is the teaming to and from a public or private landing. The wharf-boats previously mentioned are established by independent proprietors at nearly all towns and cities. They receive and store freight for or from all boats, collect freight bills and act as agents. At many of the important points several of these wharf boats may be found owned by the important boat lines operating there. At Memphis two new wharf boats have recently been put in commission. These boats are each about 50 ft. wide and 350 ft. long, and their fitness for the service is the judgment of two companies of large means operating extensively to and from this port, directed by managers who have considered in every relation the question of the most economic terminal, and willing to adopt any improvement possible.

At two points on the Ohio River, one company operating a line of boats has provided a fixed wharf-house building at the top of the bank and transfer freight to and from their boats by cars on an incline track. Again at two other points coal and sand are unloaded from barges by locomotive cranes located on top of piers above the high-water mark. These piers set out from the shore line to allow sufficient depth in low water to float the boat or barge and allow it to rise or fall along the face of the pier as the river stage varies. The pier tops connect to a landing on the shore side by tracks or driveways.

Seemingly a fixed terminal should take some such form as the last described, and the choice would rest between that and the floating wharf-boat.

Let us consider the application of these plans to Cincinnati, Ohio. The variation in level between extreme high and low water is practically 70 ft., therefore, the pier should be at least 70 ft. high. The pier should have a length up and down the stream of at least 350 ft. for each barge of that length which is to be received or discharged at one time. While the barge might lie quietly against a pier with a 10 ft. stage of water, the conditions would probably be quite different at a 40-ft. stage, and great trouble might be found to hold the barges in the current created at that point during high water. Here the floating wharf-boat has an advantage in the ability to change its berth to suit various conditions established at different stages of the river.

In the river valleys the people first occupied the low lands, most of them subject to overflow. At Cincinnati particularly, the larger manufacturers and shippers have such a location. Hence to reach a fixed terminal on a pier their freight would require first to be elevated to the highest flood level and then lowered to the barge or boat. While this objection might possibly be met, it offers another of the numerous matters which complicate any fixed arrangements for loading and unloading freight under such extreme variations of water level.

It is not a safe assumption that because a method of unloading with cranes or a particular type of terminal has been adopted abroad, it is thereby suited to the wholly different conditions that must be provided for on American rivers. Hence the broad assertion of an intention to establish boat lines and freight terminals has but small force unless accompanied by intelligent and comprehensive plans and details.

The writer does not agree that the decline of steamboat traffic on the Western rivers is due to lack of improvement in design or in construction of the boats used. He believes that the changing relation of other means of service in proportion to density of population is a more important factor.

No one will dispute that a strong organization operating steamboats with large capital, and with railroad connections, possessing such improved methods of freight handling and terminals as might be found feasible and economical, would be more likely to survive and would be more attractive to investors than the individual ownership and operation of steamboats; but such an

enterprise is not yet demonstrated to be able to attract wise investors in competition with railways, which are constantly reducing their cost of haulage.

For the benefit of those who may be interested in the further study of this subject, the writer appends some extracts from a report which he made a year or more ago to a company proposing to establish a steamboat line on the Missouri River.

In arriving at a conclusion concerning what class, type, and material you would best adopt in a boat or boats for freight transportation on the Missouri River, I beg to say in advance as respects the hull construction, that the care, preservation and maintenance of the properties, if constructed as advised, must be constant and continuous, and provided for on a broad basis of sufficient expenditure to secure these ends; otherwise, I do not advise the construction of steel hulls but conclude that your financial interests would be conserved by the smaller expenditure for wooden hulls.

From the earliest navigation by steam vessels, a line of difference has been established in the dimensions, proportion of beam to length; and of depth of hold as to both beam and length; in the kind of machinery and boilers; the steam pressure used, and the proportion of paddle wheel in diameter and length; between boats for use on water flowing into the Gulf of Mexico, and other navigation. No river coming under this division is more insistent on such individual selection than the Missouri. The shifting bed, large percentage of silt, variable channel as to depth and position, under substantially the same amount of water depth, present requirements which intensify the reasons for individual treatment.

I believe the most potent demand of these waters to be that the vessel best adapted to work upon them should, within possible limits of proper construction, "Sit on top of the water." Within ten years after what may be considered as the end of the experimental stage of steam driven boats on Western rivers, the proportion of beam to length and depth to both, reached a fixed relation within really narrow margins. Thus in the early 40's there was reached a knowledge of best proportions, which have stood the test of all later experience.

The conditions controlling the design of the boat best adapted to navigate the Missouri River between the points under consideration, are not materially different now than heretofore within the history of its navigation. At least there is nothing of difference which would justify or demand radical departures, nor can any probable improvements through dykes or dredging, likely to be made within the future covering the operation of boats now contemplated, be of a nature to influence a change in a design otherwise approved. While the effect of any greater stability to channel conditions from ordinary means, such as are usually described as river improvements, would very likely increase the efficiency of the boats herein advised, I do not see that it would indicate or permit any essential change in dimensions or construction.

KIND OF BOAT.—Concerning the kind of boat, three designs offer for serious consideration: side wheel, stern-wheel freight boat, and stern-wheel towboat and barges for freight. The only reason given for favoring a side-wheel boat for this service, so far as I know, is an assumption that the side-wheel boat can turn quicker or handle better. While such distinction might have been at one time true, it is not now a fact as between a side-wheel boat and a modern stern-wheel boat of approved model of after-body, and with sufficient and properly constructed and mounted rudders. On the other hand, the greater first cost, greater cost of maintenance, of operation, of loading and unloading, deterioration, etc., conspire in this case as they have all over similar waters, to show the wisdom of eliminating the side wheel design; therefore, the question seems to be between the employment of a single stern-wheel boat, or of stern-wheel tow boat and barges.

FREIGHT BOAT.—For a single boat unit, the dimensions should be those securing the greatest carrying capacity on the least draft of water consistent with safe and continuous operation. I believe this result will best be insured by the adoption of the dimensions shown in the drawings herewith submitted, and the corresponding detail of machinery and method and material of construction. The dimensions are 240 ft. long, from bow to stern transom, or 264 ft. over all, including the wheel, 44 ft. beam and 6 ft. depth of hold at lowest place in the side or wing, with cabin accommodation for an operating crew. On the elevation of the drawing (p. 512) are shown two load lines, one that of the light water line representing the estimated water line of the boat, without freight but ready for operation, and representing a displacement of 475 tons, which is the estimated weight, and calls for a draft of 22 ins. at the stern and 18 ins. at the bow; the second load line represents a further displacement to the maximum carrying capacity of the boat of 1,200 tons, under a maximum draft of 8 ft. at the bow and 4 ft. at the stern. This boat would carry approximately 23 tons to each inch of immersion, and on this basis (say) 700 tons on a draft of 3 ft. at the stern and 6 ft. at the bow; the total storage capacity of boat between decks and in the hold for freight, and including the forecastle, would be approximately 400,000 cu. ft. or for the 1,200 tons maximum load capacity, a weight of 24 lbs. per cu. ft. Since compressed hay or cotton weigh approximately 25 lbs., and dry goods and like shipments 50 lbs. per cu. ft., it is evident that ample capacity is provided for such freights as are contemplated. The boiler deck offers some 30,000 cu. ft. further available capacity for light freights.

HULL CONSTRUCTION.—After full consideration, I have concluded to advise the construction of metal hulls rather than wooden, although as indicated in my first interview with your board, I was not then ready to so express an opinion. The greatest reason for doubt was uncertainty of proper care being given the property. While there are, of course, exceptions, it is not far from correct to say, that the life of a wooden boat is more dependent on the condition of the timber used in its construction and the ventilation secured, than on the care given to the surface of the frames and planking. The reverse is true of the steel used in hull construction. Here the value of the hull declines rapidly unless the plates are kept constantly covered by paint or other protection against rust. Not the least determining factor against wooden hulls is that the rapid exhaustion of the supply of timber has reduced the ability to obtain such material on a par in quality with that obtainable even a few years ago. It is certain that this condition will continue and grow much more marked, seriously affecting the reliability of repairs, and making certain a greater cost for them whenever wooden boats, now constructed, would reach a condition demanding renewals.

Two objections only appear to the use of steel in hull construction. One, the greater investment in first cost. Second, the absolute requirement for thorough care of the property. I have mentioned this in the first clause of this report, in order if possible, to impress it more upon you, and I advise now that unless means can and will be provided, so long as you own these boats, to properly care for them, do not incur the greater first cost of steel hulls. Generally speaking, the steel boat, treated like a wooden boat, will not have a longer life; but properly cared for it will outlast many wooden ones.

PROPELLING MACHINERY.*—As applied to the single boat, I advise simple non-condensing engines. They insure the least weight and the lightest draft boat. To use compound-condensing engines of equivalent power would add to the no load draft, of the boat proposed, approximately 6 ins. at the stern; in which condition of no-load trim many good qualities would be lost in the way of handling, to say nothing of the loss of ability to get over shoal water. Setting out with the axiom that the prime requisite is that the boat shall "sit on top of the water," we must abandon the use of devices, however attractive, which increase the draft of the boat in its light load condition. Even aside from this, there are other considerations which would cause hesitancy. The greater complication of the mechanism requires a different grade and capacity of operating force. The available river engineers who are experienced in the operation of steam and boilers under our fuel and water conditions, are not best qualified to handle the compound condensing machinery. Engineers who might be so qualified are not familiar with our river requirements otherwise, and demand higher wages than our river boat managers are disposed to pay, so that the owner of the compound-condensing outfit encounters many troubles which he is free from with the simple design. Even though we were permitted to waive the item of greater no-load draft with the heavier machinery, it would appear from the following estimate that both sides of the sheet must be considered. For a six months' season of navigation assume the boat is in motion one-half the time.

The simple engines will use 24 tons coal in 24 hours' run. The compound condensing engines will use 12 tons coal in 24 hours. Coal costs $3 per ton, on board.

On this basis the fuel saving would be represented by say $3,200 in the six months' operation, being 12 tons each full day of boat movement, or six tons each day of the whole period, as assumed. This saving credited to compound condensing is greater by some 10% than could be expected from the actual difference in fuel consumption between the two types of machinery, but further credit is given to the condensing plan for fuel saved because of the lessened requirements for boiler cleaning.

Against this fuel saving must be set the greater cost of several items. The first cost of compound condensing equipment would be approximately $10,000 more than the cost of simple engines.

Interest on $10,000, 1 year, at 6%.....	$600
Possible additional cost of maintenance.....	300
Additional wages of engineering force.....	600
Depreciation on additional first cost per year for life of 25 years	250
	$1,750

*With an assumption of 8 ft., minimum depth of channel, there would be probable reason for some revision of this item.

So that there is a net saving of $1,450 per year for an additional first cost of $10,000, with a loss in carrying capacity of 60 tons per trip one way, making, say, 24 trips in six months at $1 per ton, worth $1,440 freight receipts. It may be true that a greater saving would be found from a possible increased cost of fuel in the 25 years assumed as the life of the boat, but on the other hand no greater cost for repairs is calculated in the case of accident or breakage to machinery. I therefore advise for this simple boat unit, the use of simple non-condensing high pressure engines with 20 ins. diameter of cylinders and 7 or 8 ft. length of stroke.

BOILERS.—The main battery of boilers should be of the double flue externally-fired type, four in number, with the usual setting in sheet iron flame bed. Numerous experiments in boilers for use in the waters of our Western rivers have established to my entire satisfaction the wisdom of adhering to the two-flued type for the Missouri River especially. These boilers, of course, should be constructed in accordance with rules of the government inspection service.*

CABIN.—The upper work above the boiler deck is limited to such construction as is necessary for accommodation of the officers and crew, and should be kept as simple and clear as will provide for this service.

TOW BOAT AND BARGES.—In the consideration of tow-boat and barges, several of the determining factors found in the single boat proposition are absent; indeed the all-determining one is absent that of the no-load light draft of the hull carrying the propelling mechanism. Here the barges must furnish the buoyancy for the freight; and assuming that the traffic in either form of boat is to be confined to a stage of water in the channel of the river of not less than 3½ ft., it is evident that the tow boat itself can fill the conditions under a (no load) light draft of say 3 ft. Under such conditions we are at once able to consider, or adopt as may be, compound condensing machinery.

Six barges each 150 ft. long, 30 ft. wide, with cargo box, steel construction throughout, would supply capacity for one tow boat, say, 160 ft. long and 30 ft. beam, there being two barges loading at each end of the route, and two barges in transit. Each barge would draw without load approximately 8 ins., and carry a load of say 10 tons for each inch of further immersion. Two barges loaded to a draft of 3½ ft. each would carry 700 tons, representing a load for the tow boat. Assuming that the tow boat with such a load would occupy double the hours of running time on a through trip as the single boat with the same load, the difference in running time would be practically offset in the ability of the towboat to avoid the delays of the other in loading and unloading.

For the towboat construction, I would advise the use of compound condensing machinery. In this case the units of the machinery itself would be lighter than in the case of the single boat and the objection to risk of breakage and high proportionate cost of repairs is relieved. The towboat has not the same time for care and cleaning of boilers as the packet boat, and the great advantage from the better water for boiler use, secured through the surface condenser is as important as the fuel saving. I believe that whenever the use of compound condensing machinery is possible on Western river service it should be employed. This I deem is not the case in the single boat unit, but entirely so in the tow-boat design.

WAY BUSINESS.—So long as the water transportation undertaken by your company is through business, the towboat and barges would be the preferable way to handle it; and this system might also be preferable for way business where a barge might be left for loading or unloading by local labor, or by the shipper or consignee; just as carload lots are handled by the railways. The towboat and barge equipment can be economically used for way business up to the point where it would be necessary to carry a crew with the boat for loading and unloading; or where the towboat itself would idly await the handling of the cargo. If, however, numerous landings are to be made for receipt and delivery of freights, the single freight boat best meets the conditions. Even then the tow boat and barges might well be used where freights at three or four points, each amounting to say one-fourth or more of the capacity of a barge, could be collected between trips of the towboat by moving the barge down stream to the various points in sequence.

THE ELBE TUNNELS AT HAMBURG have progressed so far that on March 29 the headings of the east tunnel met, while the west tunnel is expected to be holed through in another month or two. Up to the present there have been three deaths from compressed-air disease in the work. ("Zeitschrift des Vereins deutscher Ingenieure," April 16, 1910.)

*The ill-advised discrimination of the United States inspection laws against externally fired boilers for use on waters flowing into the Gulf of Mexico, prohibits attempts to increase the possible efficiency by more effective arrangement or proportion of fire tubes. Since the making of this report a form of combined water tube and tubulous boiler not externally fired, has been installed in several new boats and the reports from the operation and fuel saving are encouraging and may justify further consideration of this item.

Suggestions for a Rational Formula for Street Pavement Crowns.

By G. B. ZAHNISER.*

You can work it out by fractions, or the simple rule of three,—but the way of Tweedledum is not the way of Tweedledee.—Kipling.

Simple engineering rules can always be stated in plain English, of course, but formulas are the least ambiguous and the most compact method to preserve and convey engineering experience and practice. Formulas are not only plain English, but they are plain French, plain German and plain any other tongue.

The splendid article of Mr. Geo. C. Warren on "Paving Practice with Respect to Crowns of Roadway Pavements," in Engineering News, Dec. 2, 1909, was read with great interest and profit.

In this article and in the paper of Mr. P. E. Green (Proc. Am. Soc. C. E., Vol. XXXV., No. 6, August, 1909) are given a number of formulas for the crown and the surface curve of streets.

The writer has collected from different sources a number of other formulas for the same purpose, and it occurred to him that here, in a very small way, might be the beginnings of a possible "rational formula" with "empirical constants" that might become for street sections what Kutter's formula is to the flow of water in channels, viz., the nucleus around which may be gathered a vast amount of practical experience.

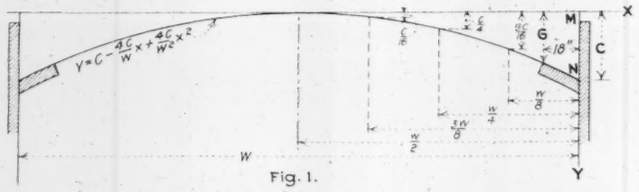

Fig. 1.

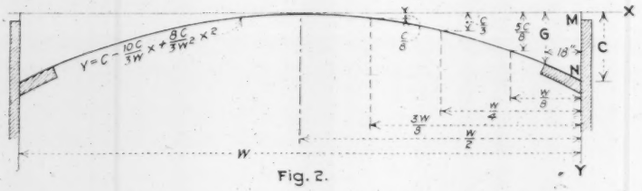

Fig. 2.

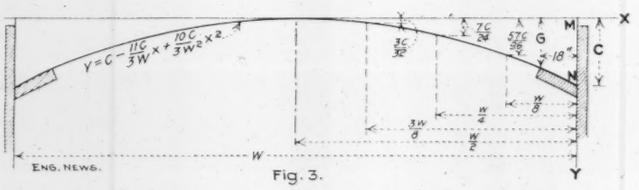

Fig. 3.

FIGS. 1 TO 3. SUGGESTIONS FOR A RATIONAL FORMULA FOR STREET PAVEMENT CROWNS.

First let us set out various rules and formulas already available.

(1)

$$y = \frac{b\,x^2}{a^2},$$

where b = depth of gutter below the grade of the center of the roadway, i. e., the crown of the street, a = the half cartway, x and y the coordinates of any point in the curve.—Paper of Mr. P. E. Green, Proc. Am. Soc. C. E., Vol. 35, No. 6, August, 1909.

(2)

$$H = \frac{W\,(100 - 4P)}{5{,}000},$$

H = crown in feet, W = width of cartway, P = percentage of grade of street.—Andrew Rosewater, late City Engineer of Omaha, Neb.

(3) Make the crown 2% of the cartway.—Reported rule of the Chicago West Park Commission.

(4A) For pavements having smooth surfaces, such as creosoted blocks, and grouted stone blocks and bricks, on streets whose grade is 2% and less, with no car tracks, make the crown of the street 1 in. to each 6 ft. of the width between curbs [the cartway].

(4B) For pavements providing more secure footholds such stone blocks, and bricks, having bitumen-filled joints; macadam or bitulithic, and on streets whose grade is 2% or less make the crown 1 in. to each 4 ft. of cartway.

(4C) If a street has car tracks, deduct the total width outside to outside of rails, from the width between curbs, and divide the difference (double the width between the track and the curb) by 6 and 4, respectively. [For Class A pavements by six and for Class B pavements by four.]

(4D) For grades between 2% and 4% use one-half the crown, provided by above computations.

(4E) For grades above 4% provide a crown, one-third that of above computations.

(4F) Provide one-third of the lateral fall between the crown and the "quarter point" and two-thirds (the fall) between the quarter point and the curb. By "quarter point" is meant the point midway between the center of the roadway and the curb, or in case of car tracks on the street, the point midway between the outside rail and the curb.

*Civil and Mining Engineer, New Castle, Pa.

All rules under (4) are those of Mr. Geo. C. Warren (p. 611, Eng. News, Dec. 2, 1909.)

(5)

$$y = \frac{4C}{W^2}\,x^2,$$

C = crown of street, in feet, W = width of cartway, in feet, x and y are the coordinates of any point in the street section.—This formula used in the practice of Major D. F. A. Wheelock, Warren, Pa.

(6) Make all gutters (not crowns) 6 ins.; let W = cartway in feet, C = crown of street in inches, then.

(6A) For block stone and brick pavements,
when W = 36 ft. make C = 7 ins.
W = 30 ft. make C = 6 ins.
W = 22 ft. make C = 4½ ins
W = 14 ft. make C = 3 ins.

(6B) For sheet asphalt and like pavement,
when W = 36 ft. make C = 6 ins.
W = 30 ft. make C = 5 ins.
W = 22 ft. make C = 4 ins.
W = 14 ft. make C = 3 ins.

(6C) For Macadam.

When W = 40 ft. make C = 9 ins. Distribute these crowns (C) across the street section each way from the center line of the street by the rule:

At one-quarter way from center line to curb drop $\frac{C}{16}$.

At one-half way from center line to curb drop $\frac{C}{4}$

At three-quarter way from center line to curb drop $\frac{9C}{16}$

The rules under (6) are from the recent practice of the city of Pittsburg.

(7) Whatever crown you use drop 7/24 of this crown half way between the center line of the street and the curb. To illustrate: When C = 6 ins. drop 1¾ ins. at "the quarter point."—Rule of Mr. J. H. Miller, for many years City Engineer of New Castle, Pa.

Now note that formula (1), a parabola, requires a crown to be assumed and then directs how to distribute it.

Note that formula (2) is for a crown in terms of width of cartway and grade of street; no method of distributing this crown is given.

Note that rule (3) is for crown in terms of width of cartway; no method of distribution is given.

Note that rules under (4) are for crown in terms of width of cartway, kinds of pavement and grades of street, and a method is given for the distribution of this crown. These rules are very good because of their wide range. There is this slight objection to them. The crown by rule (4A) for a 2% grade is

$$C = \frac{W}{6 \times 12},$$

while by rule (4D) the crown might be for a 2% grade,

$$C = \frac{W}{6 \times 12 \times 2}.$$

The writer suggests, therefore, the following as fairly representative of these rules (4). For pavements having smooth surfaces, such as creosoted blocks, grouted stone blocks and bricks, etc., Class A pavements,

$$\text{make } C = \frac{W}{36\,P},$$

C = crown in feet.
W = cartway in feet.
P = an abstract number, viz., per cent of grade on the street.

The writer suggests also: For pavements having more secure footholds such as stone blocks, bricks having bitumen filled joints, macadam and bitulithic roadways, etc. Class B pavements, make

$$C = \frac{W}{24\,P},$$

same notation as before.

If streets have car tracks, let d = distance outside to outside rails, then using the same notation we have for crown

$$\text{Class A pavements. } C = \frac{W - d}{36\,P},$$

$$\text{Class B pavements. } C = \frac{W - d}{24\,P},$$

These last four formulas would then include all of Mr. Warren's rules for crown.

The rule (4F) gives us the drop to use at one point only, "the quarter point." We must have the equation of Mr. Warren's street section to know the drop at other points, to find area for precise yardage calculations and for a number of other questions. For instance, under (4F) what drop must be made when a concrete curb with an 18-in. gutter is used, and contractor is asking for data to make his gutter template. (This formula is derived below.)

Formula (5) is the same curve as formula (1), except that the total width between curbs is used (W) instead of the half width between curbs (a). Formula (5) is somewhat more convenient to apply than (1), since $W/2$ often gives a mixed number.

Rules (6) give values for street crowns varying with the width of cartway and character of the pavement. They distribute these crown depths by equations (1) or (5), the common parabola, for it will be found by substitution say in (5),

$$y = \frac{4\,C}{W^2}\,x^2,$$

that when

$x = 0$	$y = 0$
$C = 0$	$y = 0$
$x = \frac{W}{8}$	$y = \frac{C}{16}$
$x = \frac{W}{4}$	$y = \frac{C}{4}$
$x = \frac{3\,W}{8}$	$y = \frac{9}{16}\,C$
$x = \frac{W}{2}$	$y = C$

It was discovered also by plotting the relations set out by rules (6) that they varied the crown of the street almost directly as the width of the cartway; and that considering these rules (6) as "observation equations" we could reduce them all to two equations. (6A) For block stone and brick,

$$C = 0.0152\,W + 0.0394.$$

(6B) For sheet asphalt,

$$C = 0.0112\,W + 0.0868.$$

C = crown in feet, W = cartway in feet. Now these two formulas will give C for any other value of W between W = 36 ft. and W = 14 ft.,

TABLE I.—FORMULAS FOR STREET CROWNS.

C = Crown (not always depth of gutter, in ft.); W = Cartway, in ft.; D = Outside to outside of street car track or tracks; P = Per cent. of grade.

	Grade: 2% or less.	Grade: 2% to 4%.	Grade: Above 4%.	
(2) $C = \frac{W(100-4P)}{5{,}000}$	.....	.....	.....	Asphalt. Andrew Rosewater.
$C = \frac{W(100-4P)}{6{,}000}$	.....	.....	.....	Brick, Stone, Wood, Macadam. Andrew Rosewater.
(3) $C = \frac{W}{50}$	.....	.....	.....	Chicago Park Commission.
(4)	$C = \frac{W}{72}$	$C = \frac{W}{144}$	$C = \frac{W}{216}$	For Smooth, Class (A) Cartways. G. C. Warren.
	$C = \frac{W}{48}$	$C = \frac{W}{96}$	$C = \frac{W}{144}$	For Rougher, Class (B) Cartways. G. C. Warren.
$C = \frac{W}{36P}$	.....	.....	.....	For Smooth, Class (A) Cartways. Suggested.
$C = \frac{W}{24P}$	.....	.....	.....	For Rougher, Class (B) Cartways. Suggested.
(6) $C = 0.0152W + 0.0394$	.....	.....	.....	For Block Stone, Brick, etc. Pittsburg practice.
(6) $C = 0.0112W + 0.0868$	.....	.....	.....	For Sheet Asphalt. Pittsburg practice.
(6) $C = \frac{3W}{160}$	.....	.....	.....	For Macadam. Pittsburg practice.
$C = \frac{W}{40}$	Byrnes Highway Construction			For Earth; Gravel $\frac{W}{50}$; Broken Stone $\frac{W}{60}$; Stone Block. Brick; Asphalt $\frac{W}{80}$; Wood $\frac{W}{100}$.
$C = \frac{15W}{1{,}000}$	.....	.....	.....	For Asphalt. Wabash, Indiana.
$C = \frac{14W}{1{,}000} + 0.03$	.....	.....	.....	For Asphalt. Champaign, Ill.
$C = \frac{12W \text{ to } 15W}{1{,}000}$	.....	.....	.....	For Asphalt. Indianapolis.
$C = \frac{W}{96}$	.....	.....	.....	A common rule of ¼-in. to each half foot of cartway.

Where tracks are on a street, the W of above formulas may be replaced by $(W - d)$.

according to the Pittsburg practice. As illustrating the use of these new formulas, what is the Pittsburg practice for crown when cartway is 30 ft., street paved with brick? Here $C = 0.0152 \times 30 + 0.0394 = 0.4954$ ft. $= 5.94$ ins., or 6 ins. to the nearest in.

For asphalt, 30 ft. cartway, $C = 0.0112 \times 30 + 0.0868 = 0.4228$ ft. $= 5.07$ ins., or 5 ins.

Rule (7), like rule (4F), distributes any crown in a different curve from (1) and (5) and also leaves us in doubt as to the drop elsewhere than at the quarter points.

Mr. P. E. Green, in the paper already named, remarks:

> In the Chicago ordinance the form of the roadway is generally the arc of a circle. In construction work, however, it has been found by experience that this does not give the best results and the parabola is almost always used.

The practical use of the parabola in construction work of all kinds and in the investigation of all kinds of practical questions in every branch of engineering, is too well known to need much comment. Some one qualified to do so should set out clearly in a single text-book the wonderful adaptability of the parabola.

It will be seen by the above comments on these rules and formulas that they consist of: (1) Rules for street crowns. (2) Three methods for distributing crown thus found, across the street section.

Consider now the general equation

$$y = A + Bx + Dx^2 \qquad (A)$$

We may impose three conditions on it, because of the three arbitrary constants, A, B, D.

Let W = cartway of street in feet,
C = crown of street in feet,
m = any proposed drop at the quarter point between the limits $m = 0$ and $m = \frac{C}{2}$. Let the three arbitrary conditions be:

When $X = 0$ then $y = C$
" $X = \frac{W}{2}$ " $y = 0$
" $X = \frac{W}{4}$ " $y = m$

It will be found that equation (A), after the proper reductions, becomes

$$y = C - \frac{6C - 8m}{W}x + \frac{8C - 16m}{W^2}x^2 \qquad (B)$$

In this (B) any drop m at "the quarter point" can be substituted, and the resulting equation gives any other point in the section, etc. Now by (1) and (5), $m = \frac{C}{4}$, so we have from (B),

$$y = C - \frac{4C}{W}x + \frac{4C}{W^2}x^2 \qquad (D)$$ See Fig. 1

This is the usual distribution, a common parabola, extending continuously from curb to curb.

Again by (4F) $m = \frac{C}{3}$, so we have from (B),

$$y = C - \frac{10C}{3W}x + \frac{8C}{3W^2}x^2 \qquad (E)$$ See Fig. 2

This is the curve by Mr. Warren's rule. Again by (7), $m = \frac{7C}{24}$, so we have from (B),

$$y = C - \frac{11C}{3W}x + \frac{10C}{3W^2}x^2 \qquad (F)$$ See Fig. 3

It will be found by the two last formulas (E) and (F) that the street section is made up of two intersecting parabolas, and that (E) and (F) can only be used between the limits $x = 0$ and $x = \frac{W}{2}$. Such a street section is more self-cleaning, does not wear so fast into hollows that hold water, and gives a better section than equation (D).

Now the value of C (crown in feet) can be found by any of the above rules and its value inserted in any of the three formulas (D), (E) and (F). Any other drop at the quarter point can be assumed within proper limits and the equation of the resulting section found from equation (B).

If it is desired to make the crown point of a street elsewhere than at the center line, these formulas can still be used by remembering to make W twice the distance from the curb to the

TABLE II.—FORMULAS FOR STREET SECTIONS.

C = Crown in feet, it may or may not be depth of the gutters. W = Cartway in feet.

	"Drop" when x is $\frac{W}{8}$	$\frac{W}{4}$	$\frac{3W}{8}$	$\frac{W}{2}$	Area "Nom."	Drop for an 18" Concrete Gutter G	
(B) $y = C - \frac{6C-8m}{W}x + \frac{8C-16m}{W^2}x^2$	$\frac{3C+6m}{8}$	m	$\frac{6m-C}{8}$	0			General Equation
(D) $y = C - \frac{4Cx}{W} + \frac{4C}{W^2}x^2$ (Fig. 1)	$\frac{9C}{16}$	$\frac{C}{4}$	$\frac{C}{16}$	0	$\frac{CW}{6}$	$C\left(1 - \frac{6}{W} + \frac{9}{W^2}\right)$	Common Method
(E) $y = C - \frac{10C}{3W}x + \frac{8C}{3W^2}x^2$ (Fig. 2)	$\frac{5C}{8}$	$\frac{C}{3}$	$\frac{C}{8}$	0	$\frac{7CW}{36}$	$C\left(1 - \frac{5}{W} + \frac{6}{W^2}\right)$	Suggested curve for G. C. Warren's drop at $W/4$.
(F) $y = C - \frac{11Cx}{3W} + \frac{10C}{3W^2}x_2$ (Fig. 3)	$\frac{57C}{96}$	$\frac{7C}{24}$	$\frac{3C}{32}$	0	$\frac{13CW}{72}$	$C\left(1 - \frac{5.5}{W} + \frac{7.5}{W^2}\right)$	J. H. Miller's Distribution.
(G) $y = C - \frac{130C}{27W}x + \frac{104C}{9W^2}x^2 - \frac{320C}{27W^3}x^3$	$\frac{5C}{9}$	$\frac{C}{3}$	$\frac{7C}{36}$	0	$\frac{7CW}{36}$	$C\left(1 - \frac{65}{9W} + \frac{26}{W^2} - \frac{40}{W^3}\right)$	Curve giving Mr. G. C. Warren's own suggestion as to drop.
(H) $y = C - \frac{3C}{W}x + \frac{2C}{W^2}x^2$	$\frac{21C}{32}$	$\frac{3C}{8}$	$\frac{5C}{32}$	0	$\frac{5CW}{24}$	$C\left(1 - \frac{4.5}{W} + \frac{3}{W^2}\right)$	Curve derived from McAdams' formula, Ency. Britan.

crown point. Suppose it was desired to make the crown point 10 ft. out from the curb on the 30-ft. cartway of a tipped street, then for the curve from the crown point to left curb make $W = 20$ ft. in any of the three formulas, and for the curve from the crown point to the right curb make $W = 40$ ft. in any of the three formulas. In such a case C would be the drop from the crown point to the upper gutter on one side and from the crown point to the lower gutter on the other side.

If desired also any given practice as to width of cartway could be shown in these three formulas. In New Castle and many other western Pennsylvania towns the rule is: make the cartway three-fifths of the width of street between property lines. It is a very good rule, except for wide residential streets, where it gives too wide a cartway.

If S = width of street, then by this rule $W = \frac{3S}{5}$, and this value of W substituted in the equations above would make them show this practice.

For the purpose of calculating precise yardage on streets of the sections (D), (E) and (F) it was found that the area between the limits $x = 0$ and $x = \frac{W}{2}$ was, for

(D) Area nom. $= \frac{CW}{6}$ Fig. 1

(E) " " $= \frac{7CW}{36}$ Fig. 2

(F) " " $= \frac{13CW}{72}$ Fig. 3

For the drop for a concrete curb with a gutter of 18 ins., it was found that for

(D) the drop $G = C\left(1 - \frac{6}{W} + \frac{9}{W^2}\right)$

(E) " " " $= C\left(1 - \frac{5}{W} + \frac{6}{W^2}\right)$

(F) " " " $= C\left(1 - \frac{5.5}{W} + \frac{7.5}{W^2}\right)$

The drop for any other width gutter than 18 ins. can be found, of course, directly from the equation chosen, by making x = width of gutter in feet and finding the corresponding value of y.

The radius of curvature at any point of these three sections is also readily found, having given the equation of the section, and one, of course, must have the equation of the section to get it. It is not of enough practical use to warrant its development for these three sections here.

To make the above information more available Tables I. and II. are added.

SLEEPING CARS FOR ELECTRIC RAILWAYS were introduced a few years ago by the Illinois Traction System, which has maintained a regular service between Springfield and St. Louis. Additional cars have been built recently for a service between Peoria and St. Louis, and these embody several new features which have been patented by Mr. H. E. Chubbuck, General Manager, and Mr. J. M. Bosenbury, Superintendent of Equipment and Motive Power. The former cars are of the Holland type (Engineering News, Aug. 27, 1903 and Jan. 17, 1907). The new cars resemble the Pullman type, but having the sections separated by permanent transverse partitions. An important feature is that the passenger arising in the morning can fold the berth against the side of the car, and a folding chair in the open space then facilitates his toilet. The upper berths have large windows, extending up to the eaves of the roof. Each berth has electric lights (current being supplied by storage batteries) and a small locker for watches, jewelry, eyeglasses, etc. Permanent partitions separate the sections, and at night the sections are shut off from the center aisle by curtains. The cars are not equipped with motors (as were the first cars), but will be hauled as trailers, thus eliminating noise and vibration due to the machinery. The cars were built by the American Car & Foundry Co. Sleeping cars are operated also by the Terre Haute, Indianapolis & Eastern Electric Ry., between Indianapolis, Ind., and Dayton, O.

The Status of the Engineering Profession in Great Britain.

In our issue of July 15 last we published the presidential address of Mr. Jas. C. Inglis before the Institution of Civil Engineers of Great Britain, discussing the status of the engineering profession in that country. Mr. Inglis was re-elected to the presidency, and in his second presidential address he touched on the same subject. We print below those parts of his address of most interest to American engineers. We may preface it by saying that applicants for election to associate membership in the institution are required to pass examinations. In nearly all cases, full membership in the society is attained by passage through the associate member grade, a feature which was copied in the constitution of the American Society of Civil Engineers:

I will first refer to the generally felt want of improvement in the professional status of the Civil Engineer, and to what we have done to advance it. New by-laws have been framed, and new regulations drawn up, with the object of securing a higher and more efficient standard of training than has hitherto been required, and of governing matters of professional conduct and etiquette.

A year ago I drew attention to the desirability of promoting more definite practical training among engineering students, and especially of regulating the conditions under which proof of such training should be given to the Council as a preliminary to election.

The Council studied this question long and exhaustively, and new by-laws representing their views will be submitted shortly for the decision of the members. The proposed rules are, perhaps, not so drastic as some might wish, but it was felt that in our profession the entrance should continue to be accessible, although under proper restrictions, to those whose native ability or genius may enable them to surmount a deficiency in early training.

There still appears to linger in some minds a certain confusion of ideas regarding knowledge which can be tested by question and answer in ordinary examination papers, and ability to apply such knowledge intelligently to the practical problems of every-day professional life. This institution, differing perhaps in degree, though not, it is thought, in principle, from the views sometimes entertained by other bodies on this subject, has persevered throughout in the belief that for success in the application of the great powers of Nature to the use and convenience of man, there cannot be, as a rule, any efficient substitute for regular training under those who are practising that art; albeit, the foundation of intelligent work in this direction lies in the possession of sound education and appropriate scientific knowledge.

Closely connected with this is the other matter, which I also mentioned last year, namely, that of the Engineer's personal and professional position, apart from his connection with this Institution as an organization for the advancement of science. This matter, which has been long in the minds of the Council, has been brought somewhat to a focus in the past year, in proposals for the introduction of certain disciplinary regulations into the Institution's by-laws. Speaking broadly, there is evidence of almost complete unanimity among the members, that the principles involved in these proposed rules of conduct should be adopted by the Institution. The general feeling seems to be that formal avowal by the Institution that its members are bound by a code as defined in the rules is desirable, in the interests of the professional position which the Institution seeks to foster.

I would also allude to the subject of professional fees, upon which the Council have not so far found themselves able to make any recommendation. The matter is one which is, I am aware, engaging the attention of many members; but so far the view of the Council has been that a healthy and responsible professional spirit in the Institution should achieve in a satisfactory manner the main objects that could be secured by any authorized scale of fees.

The activity of the Institution has long since ceased to be confined to its sessional period; and during the past recess we have been engaged in grappling seriously with the proposals contained in the London County Council (General Powers) Bill, 1909, as amending the Building Acts. Such Parliamentary enterprise is rather foreign to the usual course of business of the Institution; but it was felt that questions were involved of great importance to engineering construction and to the public in the future, and that the views of engineers upon these questions had not been fully realized by those responsible for the new proposals. After somewhat prolonged and arduous contention before a Committee of the House of Commons, the bill was brought into a shape which the Institution may now regard as satisfactory, and as rendering practicable the extended construction of metal-framed buildings in London. In particular, it is satisfactory to state that the important matter of appeals by engineers under the Act will be subject to an independent and expert tribunal, upon which the Institution of Civil Engineers will be represented by a member nominated by the Council.

Matters of this kind do not usually form part of a presidential address, but I have alluded to them as they are undoubtedly of very present interest to the members. Incidentally, they reflect the policy of the Council in meeting the conditions of the day, while exercising the caution and circumspection demanded when interfering with an organization so complex as this Institution.

It is, of course, well known that the object for which the Institution was formed was the advancement and improvement of professional engineering knowledge and skill; and whilst it may appear that some of the duties now undertaken are rather indirectly connected with this object, they must be considered from the point of view of the Institution as a corporate body and how far they are likely to be beneficial to engineering as a profession, and thereby to the whole body of members.

Uncertain as the outlook is at present, from the more or less continuous conflict between capital and labor, it may be affirmed with truth that students of these difficult labor problems are gradually coming to the conclusion that some form of cooperation or unity of interest between the two is desirable. As this becomes more widely accepted, and especially if at the same time it is recognized that arrangements tending in the cooperative direction will be sympathetically looked upon by the men interested, then a better era for labor will appear, and with it a more active time for members of this Institution.

The present period of unrest, want of confidence, and uncertainty is, I doubt not, already only too easily traceable in the ledgers of many members of this Institution. Unfortunately we have a significant indication from our own records that the conditions of engineering employment have become steadily and seriously less favorable during the past few years, particularly among the junior members of the Institution. The Secretary tells me he finds from his records that 10 years ago the applications from young engineers for assistance in obtaining employment were practically equal to the number of inquiries for staff received from employers. During the last 10 years our membership has increased 23%; yet in the past two years, the number of those seeking appointments has been nine times greater than the number of vacancies.

How is this situation to be met? How are we from a professional point of view to help to restore confidence and to encourage that reasonable flow of capital which is essential, if scope is to be found for our activities, and which, if obstructed and discouraged, will most assuredly arrest not only commercial progress and enterprise, but the continued advance of civilization in Great Britain? There is no royal road, no patent panacea; the only course is one which must be characterized by a capacity for adaptation to changed conditions and a readiness to adopt such methods as those changed conditions may render necessary.

One of the first matters which must claim our professional attention is the increased necessity for designs which are not merely examples of engineering ingenuity, but which combine efficiency with economy. I am very far from saying that either of these two latter considerations have not had due weight in the past; but I do say without fear of contradiction that both of them, and perhaps more particularly the latter, namely economy, must have greater weight in the future. This, of course, means that the engineer who is to contend successfully with the new conditions must be one who, by his personal knowledge of the principles of his profession in every detail, is able to evolve the most efficient methods at the least possible cost. It does not require great ability to handle a situation in which resources are boundless. True ability is that which can get the greatest result out of the least means, and without the detailed knowledge of principles to which I have alluded, this is impossible.

The successful engineer of the future, then, must possess in an increasing degree a thorough knowledge of the principles of design, of the materials to be used, and their behavior when in use (keeping in view the facility and cost of repairs) and of the actual working-conditions affecting the life of the structure or plant or machine designed. In other and perhaps plainer words, the necessity is for Civil Engineers to become more practical, if I may make bold to say so in this Institution.

By the word "practical" I mean that the engineer should not only know how to design his works, but be familiar with the conditions under which they are to be used. The practical engineer of the early part of the nineteenth century built up his theory from his personal experience, and applied his self-taught theories according to his judgment. The practical engineer of the twentieth century is he, who, knowing the theoretical principles of his profession, employs as data the facts gathered from his experience, and whose generalizations from such experience merely consolidate, if I may put it so, his knowledge of principles.

Advice Relative to Principles of Professional Practice and the Canons of Ethics.*

The American Institute of Architects, seeking to maintain a high standard of practice and conduct on the part of its members as a safeguard of the important financial, technical and esthetic interests entrusted to them, offers the following advice relative to professional practice:

The profession of architecture calls for men of the highest integrity, business capacity and artistic ability. The architect is entrusted with financial undertakings in which his honesty of purpose must be above suspicion; he acts as professional adviser to his client and his advice must be absolutely disinterested; he is charged with the exercise of judicial functions as between client and contractors and must act with entire impartiality; he has moral responsibilities to his professional associates and subordinates; finally, he is engaged in a profession which carries with it grave responsibility to the public. These duties and responsibilities cannot be properly discharged unless his motives, conduct and ability are such as to command respect and confidence.

No set of rules can be framed which will particularize all the duties of the architect in his various relations to his clients, to contractors, to his professional brethren, and to the public. The following principles should, however, govern the conduct of members of the profession and should serve as a guide in circumstances other than those enumerated:

1. Architect's Status.

The architect's relation to his client is primarily that of professional adviser; this relation continues throughout the entire course of his service. When, however, a contract has been executed between his client and a contractor by the terms of which the architect becomes the official interpreter of its conditions and the judge of its performance, an additional relation is created under which it is incumbent upon the architect to side neither with client nor contractor, but to use his powers under the contract to enforce its faithful performance by both parties. The fact that the architect's payment comes from the client does not invalidate his obligation to act with impartiality to both parties.

2. Preliminary Drawings and Estimates.

The architect at the outset should impress upon the client the importance of sufficient time for the preparation of drawings and specifications. It is the duty of the architect to make or secure preliminary estimates when requested, but he should acquaint the client with their conditional character and inform him that complete and final figures can be had only from complete and final drawings and specifications. If an unconditional limit of cost be imposed before such drawings are made and estimated, the architect must be free to make such adjustments as seem to him necessary. Since the architect should assume no responsibility that may prevent him from giving his client disinterested advice, he should not, by bond or otherwise, guarantee any estimate or contract.

3. Superintendence and Expert Services.

On all work except the simplest, it is to the interest of the owner to employ a superintendent or clerk-of-the-works. In many engineering problems and in certain specialized esthetic problems, it is to his interest to have the services of special experts and the architect should so inform him. The experience and special knowledge of the architect make it to the advantage of the owner that these persons, although paid by the owner, should be selected by the architect under whose direction they are to work.

4. The Architect's Charges.

The Schedule of Charges of the American Institute of Architects is recognized as a proper minimum of payment. The locality or the nature of the work, the quality of services to be rendered, the skill of the practitioner or other circumstances frequently justify a higher charge than that indicated by the Schedule.

5. Payment for Expert Service.

The architect when retained as an expert, whether in connection with competitions or otherwise, should receive a compensation proportionate to the responsibility and difficulty of the service. No duty of the architect is more exacting than such service, and the honor of the profession is involved in it. Under no circumstances should experts knowingly name prices in competition with each other.

6. Selection of Bidders or Contractors.

The architect should advise the client in the selection of bidders and in the award of the contract. In advising that none but trustworthy bidders be invited and that the award be made only to contractors who are reliable and competent, the architect protects the interests of his client.

7. Duties to the Contractor.

As the architect decides whether or not the intent of his plans and specifications is properly carried out, he should take special care to see that these drawings and specifications are complete and accurate, and he should never call upon the contractor to make good oversights or errors in them nor attempt to shirk responsibility by indefinite clauses in the contract or specifications.

8. Engaging in the Building Trades.

The architect should not directly or indirectly engage in any of the building trades. If he has any financial interest in any building material or device, he should not specify or use it without the knowledge and approval of his client.

9. Accepting Commissions or Favors.

The architect should not receive any commission or any substantial service from a contractor or from any interested person other than his client.

10. Encouraging Good Workmanship.

The large powers with which the architect is invested should be used with judgment. While he must condemn bad work, he should commend good work. Intelligent initiative on the part of craftsmen and workmen should be recognized and encouraged and the architect should make evident his appreciation of the dignity of the artisan's function.

11. Offering Services Gratuitously.

The seeking out of a possible client and the offering to him of professional services on approval and without compensation, unless warranted by personal or previous business relations, tends to lower the dignity and standing of the profession and is to be condemned.

12. Advertising.

Advertising tends to lower the dignity of the profession and is therefore condemned.

13. Signing Buildings and Use of Titles.

The display of the architect's name upon a building under construction is condemned, but the unobtrusive signature of buildings after completion has the approval of the Institute. The use of initials designating membership in the Institute is proper in connection with any professional service and is to be encouraged as helping to make known the nature of the honor they imply.

14 Competitions.

An architect should not take part in a competition as competitor or professional adviser or juror unless the competition is to be conducted according to the best practice and usage of the profession as formulated by the Institute. Except as an authorized competitor, he may not attempt to secure work for which a competition has been instituted. He may not attempt to influence the award in a competition in which he has submitted drawings. He may not accept the commission to do the work for which a competition has been instituted if he has acted in an advisory capacity either in drawing the program or in making the award.

15. Injuring Others.

An architect should not falsely or maliciously injure, directly, or indirectly, the professional reputation, prospects or business of a fellow architect.

16. Undertaking the Work of Others.

An architect should not undertake a commission while the claim for compensation or damages, or both, of an architect previously employed and whose employment has been terminated remains unsatisfied, unless such claim has been referred to arbitration or issue has been joined at law; or unless the architect previously employed neglects to press his claim legally; nor should he attempt to supplant a fellow architect after definite steps have been taken toward his employment.

17. Duties to Students and Draftsmen.

The architect should advise and assist those who intend making architecture their career. If the beginner must get his training solely in the office of an architect, the latter should assist him to the best of his ability by instruction and advice. An architect should urge his draftsmen to avail themselves of educational opportunities. He should, as far as practicable, give encouragement to all worthy agencies and institutions for architectural education. While a thorough technical preparation is essential for the practice of architecture, architects cannot possibly insist too strongly that it should rest upon a broad foundation of general culture.

18. Duties to the Public and to Building Authorities.

An architect should be mindful of the public welfare and should participate in those movements for public betterment in which his special training and experience qualify him to act. He should not, even under his client's instructions, engage in or encourage any practices contrary to law or hostile to the public interest; for as he is not obliged to accept a given piece of work, he cannot, by urging that he has but followed his client's instructions, escape the condemnation attaching to his acts. An architect should support all public officials who have charge of building in the rightful performance of their legal duties. He should carefully comply with all building laws and regulations, and if any such appear to him unwise or unfair, he should endeavor to have them altered.

19. Professional Qualifications.

The public has the right to expect that he who bears the title of architect has the knowledge and ability needed for the proper invention, illustration and supervision of all building operations which he may undertake. Such qualifications alone justify the assumption of the title of architect.

*Reprinted from the "Quarterly Bulletin" of the American Institute of Architects. Adopted by the Institute at the Washington convention, Dec. 14-16, 1909.

The Canons of Ethics.

The following canons are adopted by the American Institute of Architects as a general guide, yet the enumeration of particular duties should not be construed as a denial of the existence of others equally important although not specifically mentioned. It should also be noted that the several sections indicate offences of greatly varying degrees of gravity.

It is unprofessional for an architect—

1. To engage directly or indirectly in any of the building trades.

2. To guarantee an estimate or contract by bond or otherwise.

3. To accept any commission or substantial service from a contractor or from any interested party other than the owner.

4. To advertise.

5. To take part in any competition the terms of which are not in harmony with the principles approved by the Institute.

6. To attempt in any way, except as a duly authorized competitor, to secure work for which a competition is in progress.

7. To attempt to influence, either directly or indirectly, the award of a competition in which he is a competitor.

8. To accept the commission to do the work for which a competition has been instituted if he has acted in an advisory capacity, either in drawing the program or in making the award.

9. To injure falsely or maliciously, directly or indirectly, the professional reputation, prospects or business of a fellow architect.

10. To undertake a commission while the claim for compensation or damages, or both, of an architect previously employed and whose employment has been terminated remains unsatisfied, until such claim has been referred to arbitration or issue has been joined at law, or unless the architect previously employed neglects to press his claim legally.

11. To attempt to supplant a fellow architect after definite steps have been taken toward his employment.

12. To compete knowingly with a fellow architect for employment on the basis of professional charges.

A Table of Lumber Weights.

The shipping weights of the different kinds of common lumber used in the United States are given in the accompanying table. These weights represent a commercial rather than an engineering classification, as they are taken from the reports of the secretaries of the various lumber associations. They are, however, accepted by the trade in place of actual weights. The various classifications are sufficiently explanatory so that no extended reference to them is needed.

SHIPPING WEIGHTS IN POUNDS PER 1,000 FEET B.M.

	Green from saw.	Shipping dry.	Well seasoned.	Kiln dried.
Ash, black	4,000	....	3,200	3,000
Ash, white	4,000	....	3,800	3,300
Basswood	4,200	2,800	2,500	2,100
Beech	5,750	....	4,000	....
Birch	5,500	....	4,000	....
Buckeye	....	2,600	....	....
Butternut	4,000	2,800	2,500	....
Chestnut	5,000	3,500	2,800	2,450
Cherry	5,000	4,000	....	....
Cottonwood	4,600	3,100	2,800	2,400
Cypress	5,000	3,500	2,900	....
Elm, rock	5,400	4,300	4,000	3,500
Elm, soft	4,750	3,300	3,100	2,900
Gum	5,400	3,600	3,300	3,030
Gum, sap	5,000	3,300	3,000	2,750
Hemlock, Penna	4,000	....	2,500	....
Hemlock, Northern	4,500	3,000	....	....
Hickory	6,000	5,000	4,500	....
Mahogany	4,500	....	3,500	....
Maple, hard	5,400	4,150	3,900	3,400
Maple, soft	5,000	3,650	3,300	3,000
Oak, red	5,500	4,250	4,000	3,400
Oak, white	5,700	4,500	4,100	3,600
Pine, long leaf	4,500	3,500	....	....
Pine, white	3,500	2,500	2,400	2,200
Poplar	3,900	3,000	2,800	2,400
Poplar Bay (Tupelo)	4,200	....	3,000	....
Spruce, Adirondack	3,300	2,700	2,300	....
Spruce, W. Va	3,000	2,700	2,300	2,200
Sycamore	4,750	3,200	3,000	....
Walnut, black	4,900	4,000	3,800	....

A SUBSTITUTE FOR COTTON, made from spruce wood pulp, has been produced by a French inventor and samples were exhibited at the recent meeting of the National Association of Cotton Manufacturers by Mr. Jos. Hope, of Rouen, France. Cloth woven from the fiber is said to stand bleaching, dyeing and finishing as well as cotton and to have a more brilliant luster. It can be produced for much less cost than the market price of cotton and arrangements are said to have been made for its manufacture on a large scale abroad.

Framework of New 22d Regiment Armory, New York City; A Three-Hinged Arch Roof with Cantilever Skewback Supports.

A new application of three-hinged arch roof framing was made recently in the design of a new armory for the 22d Regiment of the State militia, to be erected at 168th St. and Fort Washington Ave., New York City. The arched roof trusses are supported on end pins carried by heavy cantilever beams extending inward from the side-wall columns a distance of 20 ft. 3 ins. at a height of 33 ft. above the floor. This arrangement avoided all obstruction of floor area or invasion of head clearance over floor and balcony by the arch members. Incidentally some advantages in the lighting of the hall were obtained, as a belt of vertical windows is placed below the eave of the arch roof, in a location where the light from these windows will be most effective on the floor.

The diagrammatic elevation and sections shown in Fig. 1 herewith explain the layout of the building quite fully. Its horizontal dimensions, 180 ft. wide by 427 ft. long on the shorter side, are utilized in full for the drill-hall floor, all accessory rooms being disposed on two lower floors. The arch-roof construction therefore extends over the whole building. Gable walls are avoided, however; the roof is hipped at each end; one truss bay being occupied by the hip roof, the framing of the main roof is continued across this bay by simply bending the purlins, where they strike the hip ridge, down into the plane of the hip roof. The lower ends of these purlins rest on cantilever girders extending back over the seat tiers. A skewback girder like that used

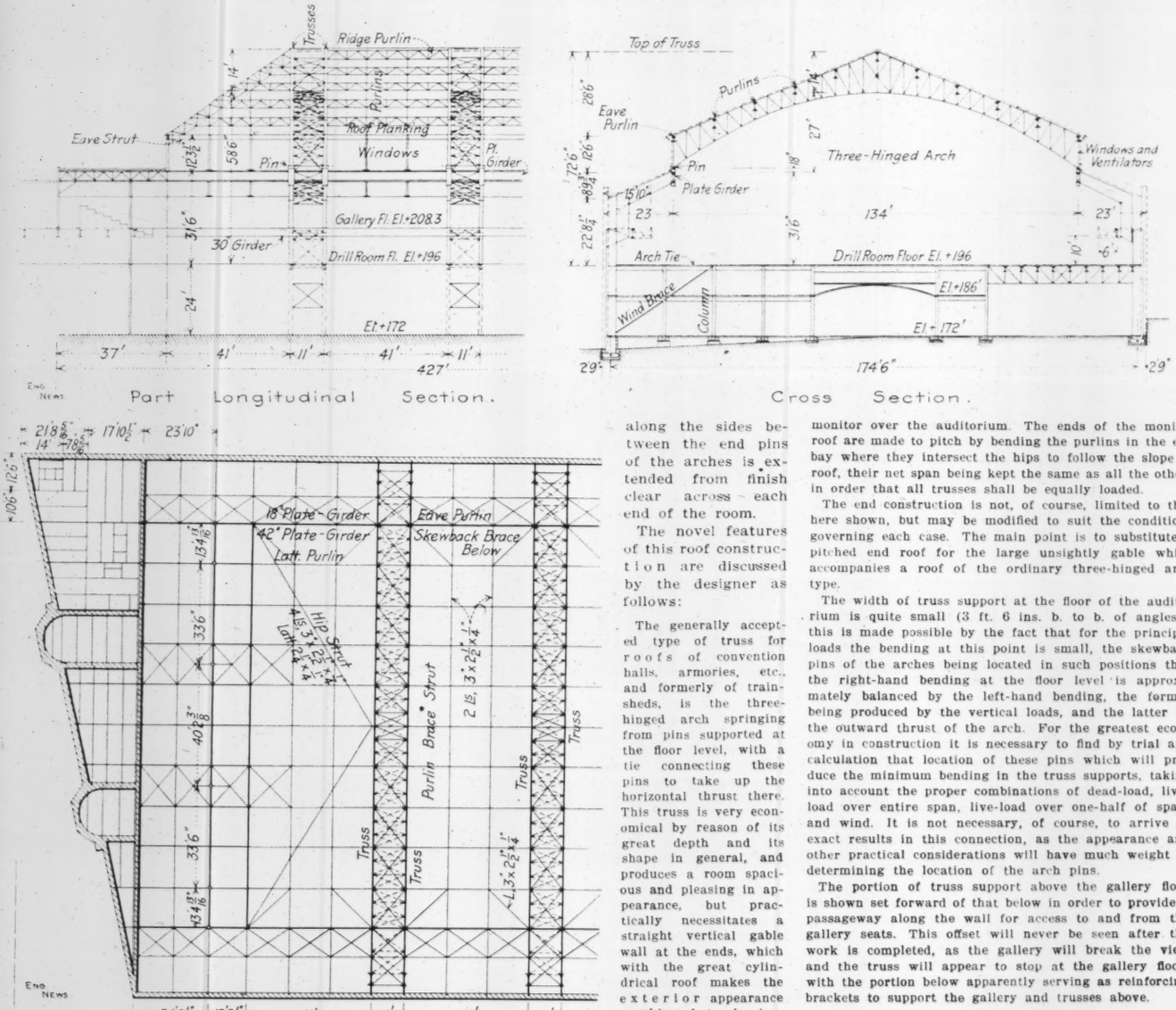

FIG. 1. OUTLINE PLAN AND SECTIONS OF FRAMING, NEW 22D REGIMENT ARMORY, NEW YORK CITY.

(Walker & Morris, Architects; Chas. Worthington, Structural Engineer.)

The roof construction of the 22nd Regiment armory was designed to meet these objections.

The roof truss is an ordinary three-hinged arch, but rests on overhanging supports, one at each side of building, providing a clerestory which is well adapted to lighting and ventilation purposes and which breaks the great ceiling of the auditorium into two distinct parts. The trusses themselves hug the ceiling closely and are of pleasing form, all of which features tend to improve the appearance, both internal and external.

The clerestory is extended continuously around the building, making the arch roof virtually an immense monitor over the auditorium. The ends of the monitor roof are made to pitch by bending the purlins in the end bay where they intersect the hips to follow the slope of roof, their net span being kept the same as all the others in order that all trusses shall be equally loaded.

The end construction is not, of course, limited to that here shown, but may be modified to suit the conditions governing each case. The main point is to substitute a pitched end roof for the large unsightly gable which accompanies a roof of the ordinary three-hinged arch type.

The width of truss support at the floor of the auditorium is quite small (3 ft. 6 ins. b. to b. of angles); this is made possible by the fact that for the principal loads the bending at this point is small, the skewback pins of the arches being located in such positions that the right-hand bending at the floor level is approximately balanced by the left-hand bending, the former being produced by the vertical loads, and the latter by the outward thrust of the arch. For the greatest economy in construction it is necessary to find by trial and calculation that location of these pins which will produce the minimum bending in the truss supports, taking into account the proper combinations of dead-load, live-load over entire span, live-load over one-half of span, and wind. It is not necessary, of course, to arrive at exact results in this connection, as the appearance and other practical considerations will have much weight in determining the location of the arch pins.

The portion of truss support above the gallery floor is shown set forward of that below in order to provide a passageway along the wall for access to and from the gallery seats. This offset will never be seen after the work is completed, as the gallery will break the view and the truss will appear to stop at the gallery floor, with the portion below apparently serving as reinforcing brackets to support the gallery and trusses above.

The details of the roof trusses (Fig. 2) require no special mention, but those of the cantilevers and columns are of further interest.

The outward thrust of the arches is taken up by a tie in the floor of the drill hall. A 12-in. channel, 35 lbs. per ft., which forms the tie is laid over the 15-in. I-floorbeam in the plane of the bent, the I-beam supporting the channel. The splices of the channel were easily enough detailed to transmit the tension, but some difficulty arose at the connection between tie and column. The column has rather high bending stresses at the point where the connection occurs, and therefore a connection which required cutting the flange of the column was undesirable. A spliced gusset connection shown in plan in Fig. 5 met the difficulties of the case.

The connection of the cantilever skewback support to the column was one of the most troublesome details. The bending stress at this point is quite large, and the connection must be made rigid. The skewback pins of the arches are located at the floor level, and the cantilever girders must be carried back over the seat tiers to a point sufficiently far from the pin to give a reasonable length of girder. The cantilever girders are therefore carried back to the column line, and the skewback pins of the arches are carried by a skewback girder which is supported by the cantilever girders. The skewback girder is a plate girder 42 ins. deep, and is placed with its web in the plane of the arch ribs. The cantilever girders are 30-in. plate girders, and are placed with their webs in the plane of the columns. The skewback girder is connected to the cantilever girders by a pair of 6-in. angles, and the cantilever girders are connected to the columns by a pair of 8-in. angles. The connection of the skewback girder to the cantilever girders is made by a pair of 6-in. angles, and the connection of the cantilever girders to the columns is made by a pair of 8-in. angles. The connection of the skewback girder to the cantilever girders is made by a pair of 6-in. angles, and the connection of the cantilever girders to the columns is made by a pair of 8-in. angles.

The novel features of this roof construction are discussed by the designer as follows:

The generally accepted type of truss for roofs of convention halls, armories, etc., and formerly of train-sheds, is the three-hinged arch springing from pins supported at the floor level, with a tie connecting these pins to take up the horizontal thrust there. This truss is very economical by reason of its great depth and its shape in general, and produces a room spacious and pleasing in appearance, but practically necessitates a straight vertical gable wall at the ends, which with the great cylindrical roof makes the exterior appearance anything but pleasing. The truss is also of considerable width at the floor level of the room, if constructed economically, which reduces the net width of room just where it is generally desired to have as great a width as possible.

Moreover, the gallery interrupts the trusses, tending to mar their appearance, while the trusses interrupt the passageway leading to the seats in the gallery. The latter defect is sometimes overcome by inserting an arched portal in each truss where the passage occurs.

With trusses of this type the room is usually lighted by a skylight, which gives an excellent light, but requires constant watching for leaks; or by a monitor construction on top of the main trusses providing vertical windows below the ridge of the roof, which construction is open to the objection that the interior appearance of lightness and simplicity in the steel framing is lost, and by flattening the roof above the monitors, requires this portion of roof to be designed for a greater

joint is heavy, and the joint not only had to be made in the field but also required to be accurate in setting, so as to bring the skewback pin to the proper elevation. A riveted torsion splice was designed, with the addition of a 6-in. bearing pin at the inner angle of the joint to assist in getting accurate setting of the joint. The arrangement is detailed in Fig. 5. The cantilever and column are butted on the miter, and a diamond-shaped ½-in. splice-plate on either side holds them together. Each flange is connected to the splice-plates by as many bolts as required to develop the full capacity of the flange material. Diagonal filler strips counteract buckling of the webs and splice-plates in line of the joint face. The pin at the inner corner, 6 × 14 ins., is fitted central to the intersection of the adjoining flanges.

The method of finishing the joint and erecting the members is specified to be as follows: The rivet holes are punched 13/16-in., all parts assembled in correct relation and temporarily bolted by ¾-in. bolts in at least 25% of the holes, and then all holes reamed in a fixed drilling-machine. As the reaming proceeds, the holes are to be filled with tightly-fitted turned bolts in place of the temporary bolts. Then the 6-in. pin-hole is to be bored, without clearance. The parts may now be separated for shipment. At the site the column and cantilever are to be assembled lying flat on the ground, the pin placed, the same previously-fitted bolts used for assembling, and the joint then fully riveted (⅞-in. rivets). The assembled members may then be raised to place.

The fastening of the skewback pin support to the outer end of the cantilever is also an interesting detail. The support is a short post made up of two channels spread 14 ins. apart, straddling the cantilever plate-girder. As the pin is above the cantilever, the connection is subjected to torsion as well as direct load. A connection only to the web of the cantilever girder would be poorly adapted to resisting the torsion. Therefore a flange connection is provided to take the thrust and torsional moment, while a web connection takes the vertical load. Vertical angles riveted to the girder web and similar opposing angles on the inside of the post have their overlapping outstanding legs riveted together; this takes the vertical load into the girder web. The flange connection consists of

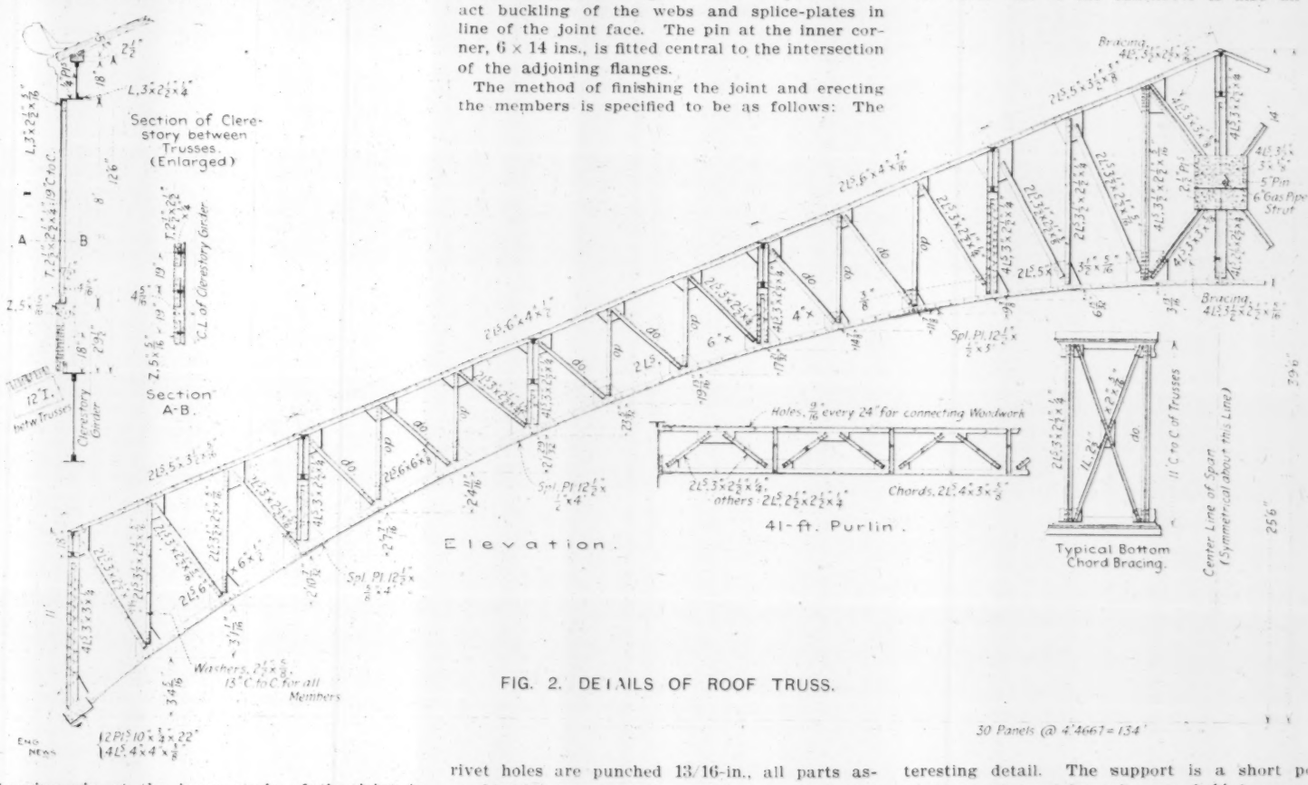
Section of Clerestory between Trusses. (Enlarged)
Section A-B.
Elevation.
41-ft. Purlin.
Typical Bottom Chord Bracing.
Center Line of Span (Symmetrical about this Line)
Washers, 2½ × ⅝ 13" C to C for all Members
30 Panels @ 4'4667 = 134'

FIG. 2. DETAILS OF ROOF TRUSS.

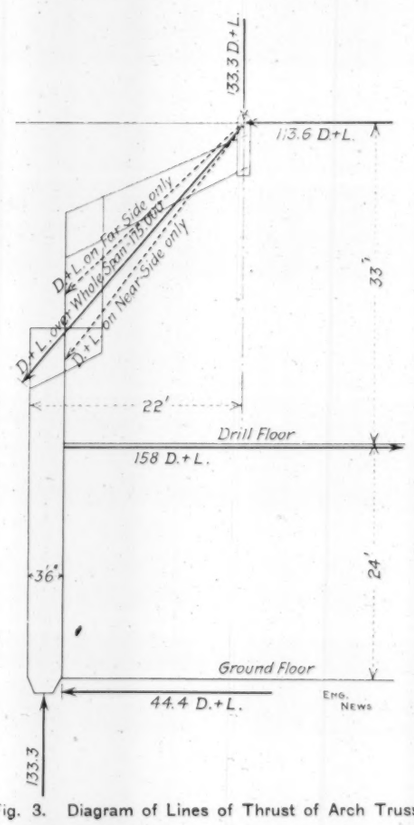

Fig. 3. Diagram of Lines of Thrust of Arch Truss.

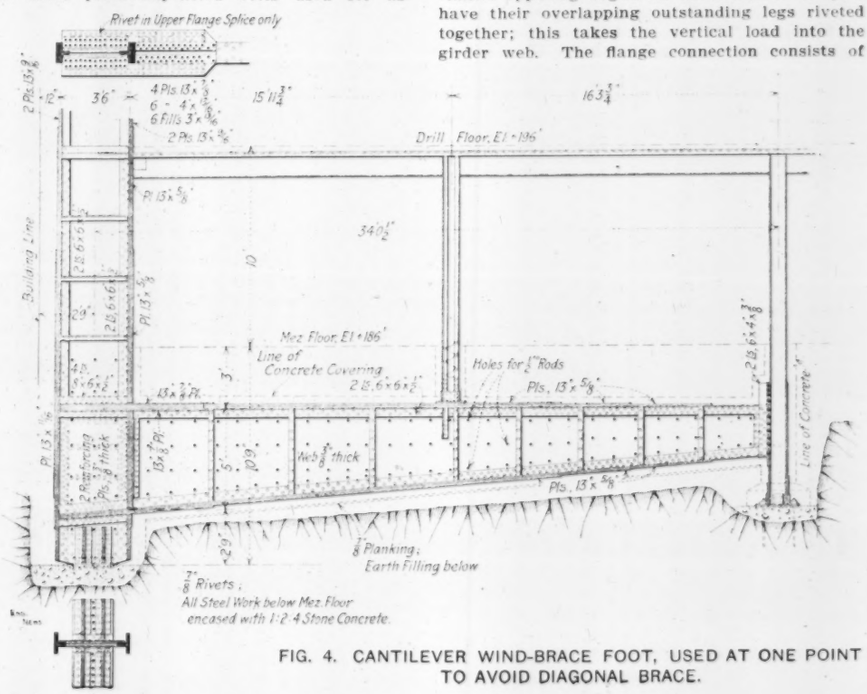
Rivet in Upper Flange Splice only
Drill Floor, El. +136'
Mez. Floor, El. +186'
Line of Concrete Covering
Holes for 1" Rods
Building Line
Web ⅝" thick
⅝ Planking; Earth Filling below
⅞ Rivets; All Steel Work below Mez. Floor encased with 1:2:4 Stone Concrete.

FIG. 4. CANTILEVER WIND-BRACE FOOT, USED AT ONE POINT TO AVOID DIAGONAL BRACE.

angle clips riveted along the edges of the flanges, close against the inner face of the post channels and riveted thereto.

At this same point is connected a horizontal plate-girder which forms a portal bracing system for the outer ends of the cantilever girders.

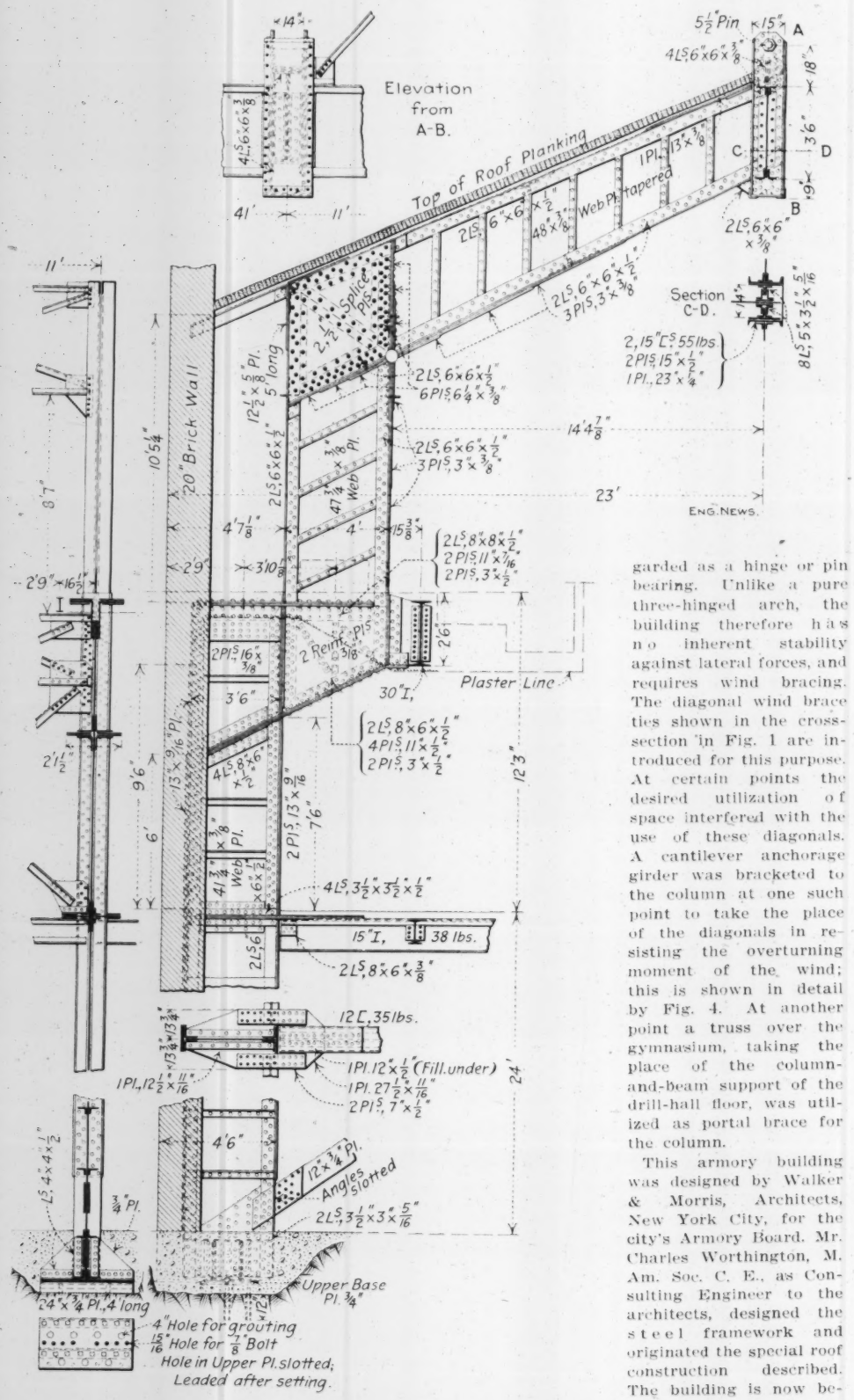

FIG. 5. DETAILS OF COLUMN, CANTILEVER SKEWBACK AND FLOOR TIE.

This is attached to the face of the post channel by the same rivets which fasten the stiffeners of the post connection.

The main column is offset a distance equal to its width, at a point about 12 ft. above the floor, to give room for a longitudinal passageway behind the gallery. The upper part is joined to the lower by a shear connection of the abutting flanges, and by horizontal tension splices 4 ft. 4½ ins. apart to resist the bending moment in the column. These tension splices are similar to the attachment of the main tie at the floor level.

The columns rest on their concrete footings with simple vertical-load shoes, not fixed to resist bending. Statically the column foot is regarded as a hinge or pin bearing. Unlike a pure three-hinged arch, the building therefore has no inherent stability against lateral forces, and requires wind bracing. The diagonal wind brace ties shown in the cross-section in Fig. 1 are introduced for this purpose. At certain points the desired utilization of space interfered with the use of these diagonals. A cantilever anchorage girder was bracketed to the column at one such point to take the place of the diagonals in resisting the overturning moment of the wind; this is shown in detail by Fig. 4. At another point a truss over the gymnasium, taking the place of the column-and-beam support of the drill-hall floor, was utilized as portal brace for the column.

This armory building was designed by Walker & Morris, Architects, New York City, for the city's Armory Board. Mr. Charles Worthington, M. Am. Soc. C. E., as Consulting Engineer to the architects, designed the steel framework and originated the special roof construction described. The building is now being erected, and will probably be completed during the year. The general contractor for its construction is the Guidone and Galardi Co.

PROSPECTING FOR BITUMINOUS COAL in northern Ontario is being carried on by the Temiskaming & Northern Ontario Railway Commission. A lignite deposit covering an area of over 100 square miles, near Cochrane, was recently discovered, and it is hoped that diamond drill borings may develop bituminous coal deposits in the vicinity.

Some Points in the Design of Impulse-Wheel Buckets.

By GEORGE M. PEEK.*

For quite a long time after the introduction of impulse wheels, the buckets were designed by the cut-and-try method. When it was found that a certain pattern gave fairly good results under one set of conditions, it was adopted as a standard, with the result that the efficiency was very low under some other set of conditions. At the present time, however, most builders of water-wheels design their buckets for each set of conditions under which they are to work.

But not all of the so-called responsible builders design the buckets especially for each case. In making tests on water-power plants the writer has encountered many cases where the simplest principles of design seemed to have been entirely ignored, and in many cases it was very evident that the manufacturer had selected a bucket pattern from stock, taking what he considered the nearest thing he had to suit the conditions and using this without modification. In a number of cases the entering lip of the bucket did not enter the stream properly, in fact the water struck the back of the bucket before the lip entered the stream. Another common defect is that the buckets are attached to the wheel at such an angle as to discharge quite a volume of water in the track of the buckets, with the result that the water discharged by one bucket is struck by those following; not only does this cause a loss of power but the reaction from this discharge also causes an increase in pressure on the shaft bearings, producing an increase in journal friction. A properly constructed baffle-plate can prevent the water from coming in contact with the following buckets, but cannot relieve the pressure on the bearings.

Fig. 2 shows a bucket inclined at the proper angle. From hydraulic considerations only, this position should be where the bucket is normal to the stream when the center of gravity G of the part of the stream A C D E, Fig. 1, has just reached the bottom of the bucket or turned through 90°. In practice the bucket should be located a little in advance of this, so as to produce an upward reaction and reduce the pressure on the shaft bearings. This position may be readily determined by the use of a pair of proportional dividers, taking into consideration the length of the path of the stream in the bucket together with the coefficient of frictional velocity-loss. If the upper part of the bucket leans to the left of the position shown in Fig. 2 there will be an upward discharge with a corresponding downward reaction, causing an increase of pressure on the bearings.

With the rectangular type of bucket shown in Figs. 1, 2 and 3, little or no water will be discharged in the track of the buckets. On the other hand, plants equipped with the round type of bucket (shown in Fig. 4) gave marked evidences of the water being discharged, so as to strike the backs of the buckets. One plant equipped with buckets of this type was working under a high head and the water contained considerable abrasive material; as a result the bucket bolt heads and nuts looked as if a sand-blast had been playing on them. This plant had been in operation a short time, yet the wear was very considerable. The efficiency of the plant was, of course, much below that guaranteed by the manufacturers.

In the following discussion of buckets the notation used is:

H = effective head, that is the velocity head of the stream as it leaves the nozzle, in feet.
P = horsepower of the wheel.
s = diameter of jet, in inches.
C = spouting velocity of the water leaving the nozzle, in feet per second.
V = peripheral velocity on the pitch circle of the wheel, in feet per second.
V_c = peripheral velocity on the outside diameter of the wheel in the central plane, in feet per second.

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V_1 = relative velocity of the water as it enters the bucket, in feet per second.
V_2 = relative velocity of the water as it leaves the wheel, in feet per second.
w = absolute velocity of discharge from the wheel, in feet per second.
D = wheel diameter on the central plane, in inches.
D_1 = diameter of the pitch circle, in inches.

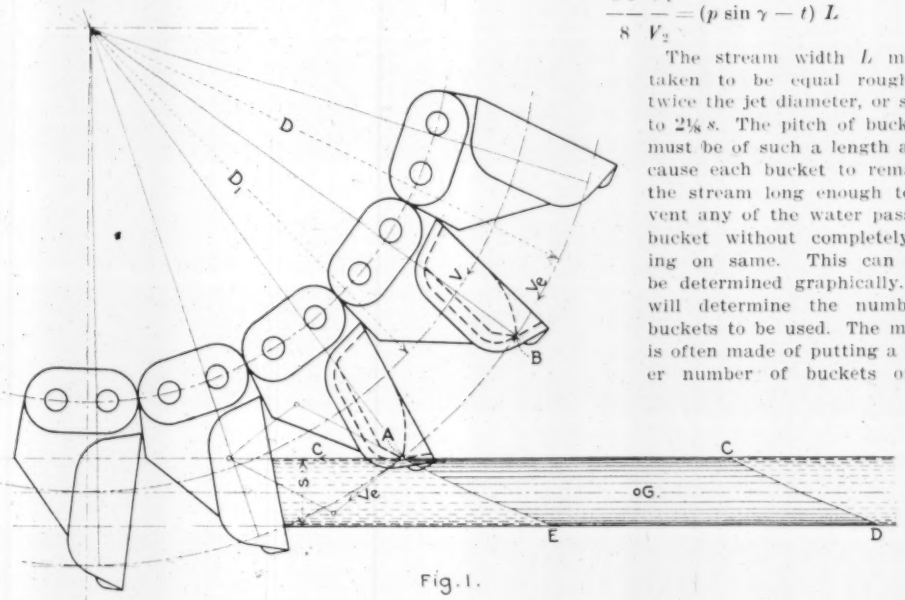


Fig. 1.

p = distance between buckets, measured on the pitch circle, in inches.
L = length of the sheet of water discharged from the bucket, in inches.
W = width of bucket, in inches.
t = thickness of the discharge edge of the bucket.
γ = discharge angle of the bucket.
f = coefficient of loss of velocity head in the bucket.
N = revolutions of the wheel per minute.
$\phi = V/C$ = ratio of wheel velocity to jet velocity.

The entering lip of the bucket should have the back tangent to the resultant of the jet velocity C and the tangential wheel velocity V_e, as shown in Fig. 3. Another section of the bucket, a short distance to one side of the central plane, is also shown in Fig. 3, with the graphical construction for obtaining the lip angle, which may be easily followed. The lip of the bucket should be carefully finished, so as to cause as little distortion of the stream as possible.

The discharge angle of the bucket may be determined as shown in Fig. 3. The relative velocity at entrance, V_1, may be taken as equal to $C - V$; the relative velocity at discharge, V_2, would be equal to this if there were no losses in the bucket. If the velocity loss in the bucket be called V_L, then $V_L^2 = V_1^2 f$ and

$$V_2 = V_1 - V_L = V_1 (1 - \sqrt{f}) \qquad (1)$$

The area of the stream striking the bucket is $\frac{\pi s^2}{4}$, and as this is divided equally between the two sides of the bucket the area of the stream entering each side will be $\frac{\pi s^2}{8}$. Since the relative velocity at entrance is greater than at exit, the area at exit would be $\frac{\pi s^2}{8} \frac{V_1}{V_2}$ and we must have, from Fig. 3,

$$\frac{\pi s^2}{8} \frac{V_1}{V_2} = (p \sin \gamma - t) L \qquad (2)$$

The stream width L may be taken to be equal roughly to twice the jet diameter, or say $2\,s$ to $2\frac{1}{8}\,s$. The pitch of buckets, p, must be of such a length as will cause each bucket to remain in the stream long enough to prevent any of the water passing a bucket without completely acting on same. This can easily be determined graphically. This will determine the number of buckets to be used. The mistake is often made of putting a greater number of buckets on the wheel, which cuts the stream up into smaller pieces and presents a greater bucket surface to the stream, with an increased friction loss.

The discharge angle is then computed as follows:

$$V_1 = C - V = C (1 - \phi) \qquad (3)$$

$$V_2 = V_1 (1 - \sqrt{f}) = C (1 - \phi) (1 - \sqrt{f}) \qquad (4)$$

Combining equations (2), (3) and (4) we have

$$\sin \gamma = \frac{1}{p} \left(.3927 \frac{s^2}{L} \frac{1}{1 - \sqrt{f}} + t \right) \qquad (5)$$

Eq. (5) is true only where ϕ and f have such values as will make the exit velocity triangle a right-angle triangle, or $V/V_2 = \cos \gamma$, in which case the loss due to the absolute velocity of discharge w will be a minimum and the direction of the discharge will be parallel to the axis of the wheel, i. e., will have no component in the direction of motion of the buckets.

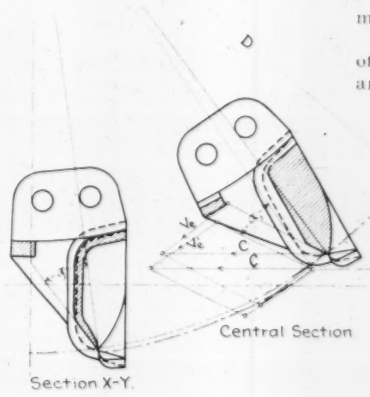
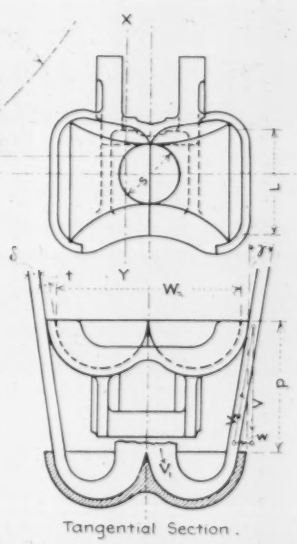


Fig. 3.



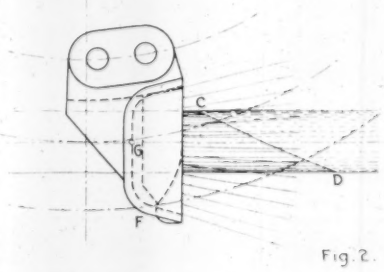
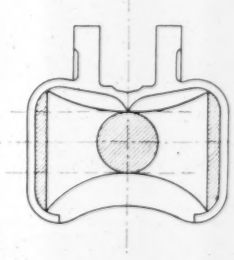


Fig. 2.



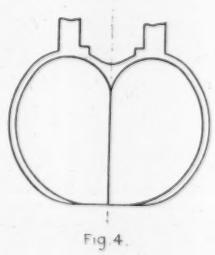


Fig. 4.

The speed-ratio ϕ may be taken at an average value of 0.43. It will be smaller as f increases, consequently the efficiency of the wheel may be increased by improving the surface of the bucket, provided the wheel speed be increased correspondingly. The bucket loss f may be as low as 5% for buckets with surfaces carefully finished to templet and polished.

From actual tests on impulse wheels I have found the best results to be gotten with ϕ between 42% and 44%. This does not mean that ϕ will always lie between these limits, because in many of these cases the bucket design could have been greatly improved, which would have its effect on ϕ.

The writer would not advise the use of a stream diameter greater than $D/16$ ordinarily. A slightly larger jet may be used in exceptional cases, though only at reduced efficiency. Assuming an efficiency of 80% for the wheel, the stream diameter s may be determined as follows:

$$\frac{\frac{\pi s^2}{4 \times 144} \sqrt{2 g H} \times H \times 62.4 \times 80\%}{550} = P$$

$$\text{or } s = 15.9 \sqrt{\frac{P}{H^{3/2}}} \qquad (6)$$

It is good practice to make the pitch diameter $D_1 = D - 2\frac{1}{4}\,s$. This is sometimes varied between $D - 2\,s$ and $D - 2.4\,s$. Taking $D = 16$ and $D_1 = D - 2\frac{1}{4}\,s$, we have

$$D_1 = D - .141\,D = .859\,D \qquad (7)$$

If we make the speed of the wheel such that its velocity on the pitch circle is 43% of the stream velocity we have

$$0.43 \sqrt{2 g H} = \frac{N}{60} \frac{\pi D_1}{12}$$

and substituting the value of D_1 in eq. (7) we have

$$D^2 = \frac{(.43)^2 \times 64.4 \times H \times (720)^2}{N^2 \pi^2 \times .738} = 848000 \frac{H}{N^2} \qquad (8)$$

From eq. (6) we have

$$\frac{D}{16} = 15.9 \sqrt{\frac{P}{H^{3/2}}}, \text{ or } D^2 = 65000 \frac{P}{H^{3/2}}$$

Equating this value of D^2 with that in eq. (8) we obtain

$$\frac{P N^2}{H^{5/2}} = 13.078$$

If $\frac{PN^2}{H^{5/2}}$ is greater than 13.078 more than one single-nozzle wheel or a wheel with more than one nozzle should be used.

The angle of the central wedge may safely be made 30°.

A good value to use for depth of bucket is 0.8 to 0.9 the diameter of the jet.

As the method of fastening the buckets to the wheel center and the determination of the thickness of the buckets are simple problems in mechanics, these details will not be entered into except to state that the fastenings should be designed to stand a runaway speed and should be strong enough to permit of the wheel being locked and the full force of the stream to strike a bucket.

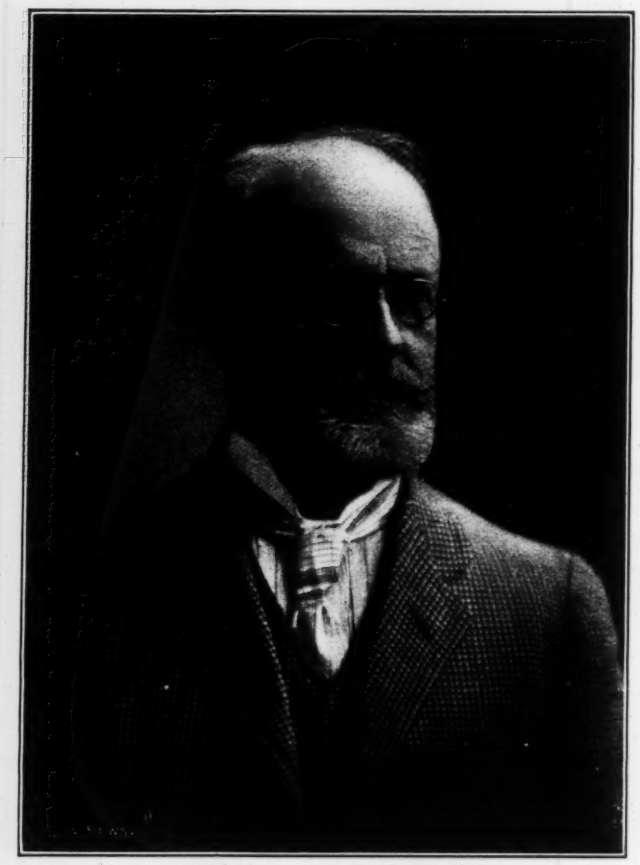
The New Chief of Engineers, Colonel William H. Bixby.

The announcement has been made at Washington that on the retirement of General William L. Marshall from the office of Chief of Engineers, on June 11, he will be succeeded by Colonel William H. Bixby. Colonel Bixby's promotion to the head of the Corps, of which he has been an officer for 37 years, is made in the direct order of seniority, as he is at the present time the ranking officer of the Corps below General Marshall. But merit and ability have great weight in the selection of officers for this important position; and both officers of the Corps and civilian engineers acquainted with its personnel will generally agree that Colonel Bixby's selection for the head of his Corps is a promotion well deserved.

Colonel Bixby's eminence as an engineer is recognized throughout the profession. During his long service in the Corps, he has had assigned to him an unusual number of tasks requiring special research and a broad grasp of the larger problems of engineering. His success in tasks of this sort is well known, and some of the reports to which his name has been attached rank as important contributions to engineering literature.

Colonel Bixby was born in Charlestown, Mass., Dec. 27, 1849. He received his early education in the public schools of Brookline and Cambridge, Mass. He entered the Massachusetts Institute of Technology in 1866 at the age of 17. It is interesting to recall that some of the men most famous among Harvard's faculty were at that time connected with the Institute. Mr. W. H. Pickering, now of the Cambridge Observatory, was an instructor in physics there, and the late President, Charles W. Eliot, was professor of chemistry at the Institute.

Young Bixby's course at the Institute lasted only one year, however. The sudden death of his father caused him to leave the Institute and take a position in a mercantile house—the firm of Linder & Meyer, chemical importers of Boston. After two years in business, he received an appointment as cadet at the United States Military Academy, from which he graduated in the class of 1873, standing at the head of his class.



Wm. H. Bixby

For two years after graduation, Lieutenant Bixby was on duty with the Battalion of Engineers in New York Harbor, doing special work in connection with the harbor mines and torpedo service, which were at that time under sole charge of the Engineer Corps. From 1875 to 1879 he was a teacher at the United States Military Academy at West Point, acting as assistant professor of engineering for two years, and principal assistant professor of engineering for the last two years. He received his promotion to a First Lieutenancy on Dec. 9, 1875.

In 1879 he was sent to France, where he took a course of instruction in the French National School of Bridges, Highways and River and Harbor Improvement Work, including inspection of work in the field during the summer vacation. He was also, during the summer of 1880, in attendance at the field maneuvers of the French Army as representative of the United States. After his graduation from the French School in 1880, he was assigned to special duty investigating the use of iron for fortification purposes in various European countries. He returned to the United States in 1882, and was on duty for a year with the Engineer Battalion at Willet's Point. His report on the use of iron for fortifications was presented in 1884. He received his Captain's commission July 1, 1883.

During the years from 1884 to 1891, Captain Bixby was in charge of the United States Engineer Office at Wilmington, N. C., carrying on river and harbor improvement and fortification work in this district. He also served during this time on several special engineer boards. He was transferred to the Newport, R. I., District in 1891, having charge of the work in Rhode Island, Southern Massachusetts and Eastern Connecticut and remained there four years.

From October, 1895, to September, 1897, he was Engineer of the Fourth Lighthouse District, including the Atlantic Coast from below New York Harbor to above Chesapeake Bay. In 1897 he was transferred to the Cincinnati District, having in charge the entire Ohio River improvement work and many of its tributaries from Cincinnati to Pittsburg. He also served as Lighthouse Engineer and Lighthouse Inspector during this time, and did much work as a member of various special engineer boards. In 1901 he was transferred to Detroit, where his work included the Great Lakes from Buffalo to Duluth with plans for the third lock at the Sault and the channel improvements in the Sault Ste. Marie and the St. Clair and Detroit Rivers.

A period of illness in 1903-4 interrupted his active work, but on his recovery in 1904 he was placed in charge of the Chicago District, where he remained three years. During his tour of duty here he was Division Engineer of the Northwestern Division, under which he had supervision of all work in the Western Great Lakes and Northern Mississippi River Districts, and had charge of the work on the special board which investigated the project for a deep waterway between Chicago and St. Louis.

In 1907 he was transferred to the St. Louis District, and during the last three years he has had the responsibility for the very important works in this section and has been Division Engineer of the Western Division and Lighthouse Engineer of the Upper Mississippi and its tributaries. He became President of the Mississippi River Commission on March 14, 1908. He was also made President of the Board of Engineers appointed to make a survey of the Mississippi River from St. Louis to its mouth, to ascertain the feasibility of a 14-ft. channel and its extension from St. Louis to Chicago. Last year he was made Special Advisory Engineer to the National Waterways Commission of Congress, and accompanied that body on its trip through Europe investigating the waterways and waterway improvements there. His promotion to the rank of Major was made in October, 1895, to Lieutenant Colonel in 1904 and he became a Colonel in February, 1908.

Probably the piece of professional work which made Colonel Bixby best known to the engineering profession was that done with the board of engineers appointed to determine the maximum length of bridge spans possible in the United States. This board was appointed in 1894 as a result of the controversy in New York City over the proposal to erect a bridge across the Hudson River with a pier in the center of the river. The promoters of the enterprise claimed that it was impossible to build a bridge across the river with the span of about 3,000 ft. which would be necessary if no piers were permitted beyond the bulkhead lines. The navigation interests opposed the placing of a pier in the river, and claimed that if the construction of a bridge was necessary, a span of 3,000 ft. was feasible. The Board of Engineers, in an exhaustive report, sustained this latter contention, and the Government's permission for the pier in the river was refused.

Among other notable works with which Colonel Bixby's name has been connected was an inspection of the destruction wrought by the Charleston earthquake of 1886; a determination of the qualities of Portland cement and an investigation of slag cements; the adoption of regulations for the use of water power at the outlet of Lake Superior to prevent interference with navigation. Of at least equal importance, however, with any and all of these was the report on the Lakes-to-the-Gulf Deep Waterway, presented last year by the board of which Colonel Bixby was chairman. Our comments on this piece of professional work are doubtless so fresh in the minds of our readers that they need not be repeated here.

Colonel Bixby became a member of the American Society of Civil Engineers in 1882. He is also a life member of the American Society of Mechanical Engineers, a member of the British Association of Civil Engineers, the French Society of Civil Engineers, the United States Naval Institute, the United States Military Service Institution, both the American and British Associations for the Advancement of Science, the American Economic Association, the International Congress of Navigation and several other prominent organizations.

THE NEW POWER PLANT being built by the Illinois Traction System at Venice, Ill., will supply current for operating the traffic over the new St. Louis bridge and also for operating the southern lines of this electric railway system, which are now supplied from several smaller power plants. The new plant forms half of a future station with a total generating capacity of 28,000 HP. The present building is 138 × 192 ft., and is divided into four sections: (1) boiler room 80 ft. wide; (2) engine room 73 ft. wide, with a 30-ton traveling crane 44 ft. above the floor; (3) a division 12 ft. 3 ins. wide for pump room, switchboard room, engineers' offices, lavatories, etc.; (4) transformer room 18 ft. 3 ins. wide, with high-tension switch room above. The foundations are supported by Raymond concrete piles.

The generating plant of the present part of the station will include a 1,000-KW. alternating-current generator driven by a Corliss engine and a Curtis turbo-generator of 3,000 KW. A 5,000-KW. Curtis turbine and a 3,000-KW. generator driven by a vertical engine are provided for also. The boiler room has capacity for 12 water-tube boilers of 600 HP., equipped with superheaters and chain grates. The two steel stacks will be 12 ft. diameter and 200 ft. high. A spur track from the bridge enables coal cars to be run directly over the 1,400-ton coal bunker, which is in the middle of the boiler room.

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Those of our readers who are interested in the discussion of the Lakes-to-the-Gulf deep waterway project will find much of interest in the admirable paper by Mr. Robert S. Taylor, of the Mississippi River Commission, which is published elsewhere in this issue. The paper is an excellent presentation of the reasons why the Federal Government should assume responsibility for the regulation and control of the lower Mississippi River.

There is little doubt that this is the explanation of the active part played by New Orleans and the lower Mississippi valley in the promotion of the Lakes-to-the-Gulf navigation project. As Mr. Taylor plainly shows, the cooperation of the United States is absolutely necessary for the effective reclamation and protection from floods of the vast area of fertile land in the delta of the lower Mississippi. The planters may be able to build the levees to protect their lands; but to make the levee system permanent the banks of the river at danger points must be revetted and prevented from erosion. Otherwise the great stream will change its course at one point or another from time to time and swallow up great areas of reclaimed land.

According to law and precedent, this work by the Federal Government must be done for the ostensible purpose of improving navigation. Hence, Congressman Ransdell, of Louisiana, and other prominent men of that region, are among the most active workers in the campaign for waterway improvements. Their interest is not so much in the rivers as great avenues for transportation, as in the preservation of a great productive region from the Mississippi's floods.

It is true that hitherto government appropriations for the Mississippi River have been made avowedly to improve the river for navigation. It is worth considering, however, whether Federal appropriations for the control of this great river might not be justified on broader grounds.

We may compare the regulation of the lower Mississippi River with the construction of storm-water drains in a city. It is manifestly unfair to assess the entire cost of constructing such drains solely upon the lands in the lower part of the city which are subject to overflow until such drains are built. Equity requires that the owners of property on other parts of the drainage area from which the water is discharged onto these flooded tracts, should share in the cost of taking care of this flood water properly and preventing it from doing damage. Thus, in the lower Mississippi Valley, while the residents there are properly assessed for at least the bulk of the cost of the levees which hold the river within bounds, it is entirely fair that the residents on the great area drained by the tributary streams whose flow creates the floods in the lower Mississippi should do their share toward preventing damage in the lower reaches of the river.

Of course, to assess these costs upon the particular area included in this great river basin would be impossible. The most equitable plan, therefore, is for the Federal Government to take the responsibility and to pay from the Federal treasury a part at least of the cost of regulating the great interstate rivers.

Everyone realizes how rapidly wooden bridge floors decay. Yet such floors continue to be used quite extensively, and because they are cheap and light they doubtless will continue to be used, for small bridges at any rate. Practically nothing has been done in the way of developing means for retarding or preventing the decay of such floors. Creosoting has been resorted to, though only in a few instances; this represents practically all that has been done in the way of protection. Recently, however, a simple and attractive suggestion has been made* by a German engineer named Schiller. Instead of trying to make the timber proof against the effects of moisture, as in creosoting, he proposes to keep moisture away from the woodwork by a waterproofing upper covering.

His plan refers specially to floors which have a macadam or similar wearing surface. The floor planking is covered with two layers of tarred or asphalted paper or fabric, laid to break joints and cemented together with pitch or asphalt. The sand cushion base for the pavement is spread directly over the waterproofing. In case the stringers also are of wood, they are separately protected by a cap sheet of the waterproofing material, the floor planking being laid over these caps. When these arrangements are fully carried out, the only place where moisture can reach the floor is on its lower side, and here a protecting ceiling can be applied if desired.

One good point of this suggestion is that it has gone through a practical trial. A small wooden bridge in Germany was protected in the way described, some 15 years ago. Recently a new pavement had to be put on, and this showed up the condition of the floor. The woodwork as well as the waterproofing paper were found entirely sound. Yet there had been no maintenance work in the interim, except occasional painting of the fascia boards of the outside stringers with an oil preservative.

The old Burr bridge at Waterford, N. Y., across the Hudson River burned down in 1909, having had a life of over 100 years. Many other wooden bridges still exist which date from the middle of the last century or earlier. Most of them, we believe, are roofed over, so that the trusses and floor are well protected from moisture. Their long life demonstrates the durability of suitably protected woodwork. In the case of a bridge floor, the same result should be obtainable through waterproofing properly applied; and the cheapness and simplicity of the method argue strongly in favor of giving it a trial.

Joseph M. Huston, architect of the Pennsylvania State Capitol, was found guilty last week of participation in the extensive contract and equipment grafting for which that building furnished the occasion. There are many cases against Huston, all for letting exorbitant and fraudulent bills go through. The present trial was for certain extraordinary payments for specially designed furniture, under a contract by which the contractor was to be paid at so much *per foot*. Nothing indicated whether he was to charge per lineal foot, per square foot, or per cubic foot; and apparently, when he furnished a desk, let us say, he chose the measurement which gave the best price for that particular article. But the effrontery of this ridiculous contract was not the basis of indictment. The fact is that the bills rendered exceeded even the possibilities of such a contract. When it was shown at the trial that a given bill could not be made to fit, no matter how the "foot" was measured, and that Huston had certified this bill to be correct, the case was proven.

But a most remarkable element was introduced by the defence at this point, an element sufficient in itself to make the trial memorable in the annals of architecture. The defendant's lawyers did not try to show the bills correct; they were forced to concede them to be wrong, even fraudulent. But they claimed Huston had nothing to do with the fraud. They put a number of architects on the stand—reported as *prominent* architects—and had them testify that it was not the architect's duty to certify correctness of *quantities*; that the architect was devoted solely to quality, his certification meaning only that the material furnished was up to the required grade of beauty and excellence; and that the whole responsibility for approving the correctness of quantities in bills rested on an inferior employee, the "clerk of the works."

According to the Philadelphia "Record" an architect, Schermerhorn, was asked whether it would be the duty of an architect to see that measurements, weights, quantities and item numbers should be looked after under such a contract as Huston's employment contract.

"Certainly not," he replied.

"What, under the customs and usages of architects, would be the duties of an architect in a contract such as this," asked Attorney Graham.

"To observe that his designs and working drawings were carried out," answered the witness.

Four other architects testified similarly. The argument was stated by the defendant's counsel, as reported in the "Public Ledger," thus:

> Five reputable architects have testified under Huston's contract he was justified in doing as he did in the matter of certification, and expressed their opinion that his certificate did not make him liable for weights and measurements. . . . If Mr. Huston had employed a clerk of the works to make measurements, weigh goods and approve them, and had issued a certificate upon the approval of the clerk, then some responsibility might have attached to him. But the clerk of the works was the Superintendent of Public Grounds and Buildings. He was employed by the State. And all Huston had to do was to certify to the plans and specifications.

What did the architect's certification of contractors' bills mean, if not that material in accordance with the bills had been furnished? To the credit of the architectural profession be it said that the amazing testimony of "five reputable architects" did not go wholly unchallenged. The prosecution put architects on the stand who testified in accordance with the common-sense view that the architect's approval on a bill or estimate means that the material has been furnished and is properly billed. J. H. Rankin testified (Philadelphia "Record"):

> Under the custom among the profession the architect is responsible for whatever facts are stated in the certificate.

And specifically referring to the certificate issued by Huston to Sanderson (furniture contractor) he said that under that certificate the architect

> would necessarily be required to ascertain the amount due. The architect's certificate is a professional opinion that the contract is being properly performed.

Four other architects testified similarly. They held that though Huston's contract may not have required him to supervise, yet when he issued certificates as to correctness of the bills he assumed full responsibility for the contents of the certificate.

The importance of this matter to engineers is that in all contract law the architect and the engineer are considered to occupy equivalent positions. The law of contracts as it exists for the engineer is directly affected by any decision as to the duties of an architect. Therefore it would have been satisfying had the judge in his charge to the jury made a clear-cut pronouncement on

*In "Zentralblatt der Bauverwaltung" of April 16, 1910.

the status of the law relating to the remarkable contention of the defence. He did not do so, perhaps because a decision could be reached without invoking the legal principles governing the point. The judge went so far as to declare the architects' testimony of small importance in the case. The following extract, quoted in the "Public Ledger," gives an idea of his attitude:

All Sanderson was entitled to charge was $10.80 per foot. We have been given no light as to what per foot means, whether it means lineal, square or cubic. The Commonwealth has produced desks to show the falsity of the measurements. It is for the jury to determine if there is ambiguity about Huston's certificate. The jury must determine how the amounts in the bill were obtained. We are bound to say to you that the contract of employment of Huston, as it appears from the resolution of the board, the correspondence and the so-called Kidder's handbook shows that no duty was imposed on the defendant to measure or weigh articles. The question is, how did the parties to the contract regard it? . . . The real question is what he regarded to be within the scope of his employment. This will be determined by what he actually did. What did the defendant intend to do and what did he honestly believe he was doing must be ascertained. The jury must see what reliance could be put on the testimony of the lad who said he put the word "superintendence" in Huston's bills without the knowledge of the defendant. The jury must determine whether Huston could honestly certify to correctness of designs when h: had not furnished plans.

We have therefore in this case only the absolute contradiction of two sets of five architects. They testified as to the custom or usage among architects. It may be conceded that among architects there are some customs and usages which are beyond reason. Certainly the only view that has reason or equity to back it is the simple view that an unqualified certificate, or signature of approval of a bill, or official quantity estimate, or any similar document, is an authoritative opinion that the work mentioned or billed has been done properly and fully and is correctly billed. And so far as our knowledge of the law extends, this view has always been taken by the courts.

Of course the real point of Huston's case did not reside in this legal or formal point of the meaning of a certificate. The moral question, or rather one of many concerned, was well summarized by the State's Attorney Cunningham, as reported in the Philadelphia "North American":

They say that the word "approved" doesn't mean that the contractor was entitled to the money, but merely that the furniture conformed with the special designs which Huston was under contract with the State to draw. Unfortunately for the defence, if it meant that, it is false, because not a single one of these 277 desks was made from any design, plan or specification furnished by Huston.

If there was any justification at all for soaking the Commonwealth these outrageous prices for the desks, it might have been argued on the basis of Huston's work in preparing the designs for them, but so far as the testimony in this case goes there isn't a scintilla of evidence to show that he even prepared a single design. What's the use of all this talk about conformity, when there is nothing to show that there were any of Huston's designs to conform to?

Who did design these desks? Why, the witness Holton, who testified here, and the Derby Desk Co., of which he was factory superintendent. Don't you see how rotten this whole thing is? The deeper you go into it the sicker it makes you think of it. Not a single desk of these 277 was designed by the man—the defendant Huston—who was employed and paid by the State to do that work. . . .

He got four per cent. For what? He didn't prepare any plans. What did he do? Absolutely nothing except to attach his beautiful signature to this bill. That may be an artistic signature, but it's a mighty expensive one. It cost the State on this bill alone $2,400, and all the State got was the signature.

One can only echo the remark "How rotten this whole thing is." There was nothing architectural, nothing professional about it. It was a plain case of taking money for professional service under a false pretence of making special designs, fraudulently disregarding a contractual duty, and then, whether by negligence or design, enabling others to obtain enormous overcharges from the State—for whom the architect was acting in trust.

The Status of Producer-Gas Power Plants in the United States.

The development of the producer-gas power plant in the United States has recently been investigated by Mr. R. H. Fernald, M. Am. Soc. M. E., Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, who has also been Engineer in Charge of Gas-Producer Tests of the U. S. Geological Survey.*

The work of the Geological Survey in this field began with tests of coal and lignite at the coal testing plant of the Louisiana Purchase Exposition in 1904, was transferred to the Jamestown Exposition and is now carried on at the fuel-testing plant in Pittsburg. These tests were undertaken, in part, to determine the value of the gas producer as a means of increasing efficiency in the use of the coal resources of the country. From the first it was evident that many coals which were unsatisfactory for use in steam boiler furnaces could be made to produce twice as much power as is obtained from even the best grades of coal in a boiler plant, if these poorer grades were converted into producer gas and used in gas engines.

Although the invention of the gas engine dates back to the '70's or earlier, it did not come into extensive commercial use until the late '90's and the greatest progress has been made since 1900. At first the only available fuel for such engines was illuminating gas, which at that time was generally so expensive that the engines were not commercially practicable except for very small powers. Cheap gas was essential for the development of the gas engine. The invention of fuel-gas producer systems in the '90's and the utilization of the unburned gases from the stacks of blast furnaces, offered two sources from which cheap gas could be obtained.

Following these developments, the gas engine has had a rapid growth in size. Only ten years ago a 600-HP. unit exhibited at Paris was regarded as a wonder, while to-day four-cycle, double-acting engines of 2,000 to 3,500 HP. can be found in several steel plants. There are American plants containing units rated as high as 5,400 HP.

Three types of gas producer have been developed. The "suction producer," with which the gas engine develops its own charges of gas in the producer by means of its own suction strokes, was introduced into Europe several years ago and is now in use everywhere. The pressure producer has the air and steam forced into the producer by a blower or jet and the gas produced is stored in a holder until required by the engine. As the generation of gas does not depend upon the suction stroke of the engine, tars and other impurities may be more readily removed and the use of bituminous coals and even lower grade fuels become possible. The pressure producer was followed by the "down draft" type, in which the tarry vapors are fixed as permanent gases by passing downward through the bed of incandescent fuel. A few scattered gas-producer plants were installed for power generation before 1900, but nearly all the plants now in operation have been installed since.

At present there are some 500 producer-gas power plants in operation in the United States, ranging in size from 15 to 6,000 HP. About 88% of these are operated with anthracite coal or other smokeless fuel, while bituminous coals and lignites are used in the remaining 12%. Of the total horse-power, however, approximately 57% is derived from bituminous coals and lignites and 43% from anthracite and coke. The individual bituminous plants average 12½ times the capacity of the anthracite.

To see the cause of the growth of the producer plant, one needs to recall a few figures given by Prof. Fernald. In the ordinary factory steam-power plant, something less than 5% of the energy in the coal is converted into power. The results, obtained in the government boiler and producer tests of many fuels and believed to be fairly representative of ordinary types of commercial apparatus, have shown that where an average efficiency of about 5% was obtained with the steam plant, the same fuel in the producer plant showed an efficiency of 13.5%. The results of tests with 75 coals, six lignites and one peat showed an average ratio of fuel fired per brake-horse-power in steam-boiler compared with producer plants, of 2.7 to 1. The average ratio for lignites and sub-bituminous coals was found to be 2.7 also, and for peat, 2.3. These figures include not only the coal consumed in the gas producer itself, but in all auxiliaries. Several low-grade coals and lignites that proved nearly worthless under the boiler gave excellent results with the producer. These tests were made with a simple steam engine in one series and with a vertical three-cylinder single-acting gas engine in the other. Prof. Fernald holds that any betterment in the steam figures that would have accompanied the use of a compound engine would be offset by tests with a more modern gas engine and with producers better adapted for the various special fuels tested. For these reasons, the ratios of efficiency are held to apply approximately to higher grade plants of both kinds.

In 1906, and again in 1909, the manufacturers and the users of producer-gas plants throughout the country were asked by officers of the Survey for opinions as to the difficulties in the way of a more rapid introduction of gas-power plants. Numerous plants in various parts of the country were also observed in regular operation. Prof. Fernald sums up the principal difficulties reported, under the following heads:

(1) It is still commonly believed that the gas engine plant cannot be so reliable as the steam engine. This obstacle to development is generally believed, by the manufacturers at least, to be largely due to lack of information. It is certain that gas-power plants are being operated with perfect reliability and satisfaction, where the conditions have been properly studied and the apparatus has been selected to meet these conditions.

(2) The lack of enginemen, experienced in operating producer-gas plants, is still a difficulty at times. The situation is much better than three years ago and this trouble will disappear in time.

(3) Inexperienced salesmen—men not familiar with the details of the engines and producers they sell and uninformed as to the conditions of selection of apparatus for best operation—are still in the field but, by attention from manufacturers, they are being eliminated.

(4) The influence of a large number of unsuccessful gas-power plants installed during the earlier period of development has not entirely been overcome by knowledge of the success of the best designs of reliable companies. Some unsuccessful installations are found in recent plants of the unexperienced manufacturers and also where some new designs have been tried out. Poor design and construction in some of the apparatus still being marketed reflect on all apparatus. The reliable companies offer a well tried, well built machine, which others imitate with a cheaper equipment having a similar external appearance.

(5) Many factory buildings must be provided with a heating plant separate from the power plant, if a gas engine is installed. This prevents the sale of many gas-power units, which would be made if a satisfactory way were devised for this heating.

(6) While the investigations of the Survey have demonstrated that an excellent gas can be made from bituminous coals, yet the lack of types of producers which will *satisfactorily* gasify such fuels is still felt. In the "up-draft" producer the mechanical extraction of tar is troublesome. In the "down-draft" system the excessive labor in cleaning the fires prohibits the continuous operation of most single-generator plants. Inability to use still cheaper fuels has to be contended with. Although a few plants are operating successfully on lignite, there is opportunity for further development here.

(7) Lack of complete knowledge as to how successfully the various fuels in different localities can be used, while an obstacle at present, is being relieved by the work of the Geological Survey. As the results of its tests are published, information will become available concerning the various fuels of the country.

(8) The excessive first cost of gas-power plants over steam plants is felt. For the larger complete installations, say, from 4,000 to 5,000 HP., the cost is about the same as of a first-class steam plant of the same capacity. With smaller installations the steam plant costs considerably less. Some manufacturers have stated that the high selling cost of gas-power plants is not warranted by the shop cost. This probably results from the cost of development of new apparatus and the expense of educating purchasers

*Prof. Fernald's report is printed as Bulletin 416 of the Geological Survey.

to the proper use of gas plants. Nevertheless, even if the steam plant costs 15% less than the gas plant, the increased efficiency in operating the latter will make up the difference within two or three years. This would hold true of course only where the hours of operation or of heavy-load periods were long enough so that the total decrease in fuel charges could equal or exceed the extra fixed charges.

Producer-gas plants of 20 to 2,000 HP. capacity cost from about $105 to $46, respectively, per horse-power of installation exclusive of buildings and foundations. Including buildings and foundations, these figures will be $108.50 to $47.50. Complete plants of the larger type from 1,000 to 5,000 HP. capacity cost from $93 to $70 per horse-power, including foundations, buildings and all auxiliaries.

(9) Over-rating of American producer plants has come about very naturally through the adoption of European figures for rates of fuel consumption in the days of early development. Experience has shown that American fuels are so decidedly different that equally decided modifications in the fuel rates must be made. Some manufacturers are now re-rating their apparatus, while others are still using grate areas too small for the loads on the producers. In inspecting a large number of installations throughout the country, this point was given special attention. It was observed frequently that with a good anthracite fuel no difficulty was experienced in working the producer up to 50 or 75% of the rated capacity, but if the apparatus was forced to its full rating for any length of time, clinkering and other operating difficulties were met. These were often sufficiently serious to necessitate a reduction in load at a most inconvenient time.

The Most Economical Type of Vessel for Navigating Western Rivers.

In connection with the current agitation for the improvement of inland waterways, one of the most important questions relates to the type of vessel to be used upon these waterways. We are fortunate in being able to present to our readers in this issue a discussion of the design of steamboats for use on Western rivers which has been prepared by one of the most competent engineers in this field. The author of the paper, Mr. John M. Sweeney, M. Am. Soc. M. E., of Chicago, has built more than 200 steam vessels for use on the Mississippi and its tributaries, and has had many years of experience in the peculiar conditions which have to be met in the navigation of these streams. This is a subject on which comparatively few engineers possess information, and on which little that is valuable is to be found on record in engineering literature.

Too many engineers have without sufficient thought accepted the idea that depth of channel is an important element for economy in river navigation just as it is in the navigation of the ocean or the Great Lakes. It is this idea that forms the basis for the popular agitation for "deep waterways."

The careful reader of Mr. Sweeney's paper will perceive, we are sure, the great advantages for river navigation in swift currents of the shallow-draft vessel, drawing 6 to 8 ft., compared with the deep-draft vessel drawing, say, 15 to 20 ft.

One great advantage of the shallow-draft vessel, carrying its load upon a broad, flat deck, is the convenience and economy with which it can be loaded and unloaded. Either merchandise or bulk freight can be quickly and easily placed upon a flat, broad deck and can be readily reached for unloading. With a deep-draft vessel, on the other hand, such as the typical lake or ocean steamer, the freight must all be lowered into a deep hold by derricks on the ship or the wharf.

It is true that where certain bulk freights, like ore or coal are handled in great quantity, mechanical methods of loading and unloading can be adopted; and the cost of stowing freight into and hoisting it out of deep holds can be greatly reduced. But there are only a few traffic routes where the business is large enough to make the use of such mechanical methods of loading and unloading profitable. The fact remains, therefore, that for all ordinary freight and for bulk freight where the business is not of great volume, the vessel carrying its load on a broad, flat deck is far superior to the vessel with deep hold. Of course for navigating the stormy waters of the ocean or the Great Lakes the vessel must have its lading protected by the solid walls of the hull at the sides and a solid deck above. No such necessity exists in the navigation of inland rivers, hence the vessel carrying its load on a broad, flat deck—the typical river steamboat—is not only far less costly to build than the deep draft ocean vessel, but far less costly to load and unload.

There is another reason why the shallow-draft vessel is better by far for river navigation than the narrow, deep hulled vessel used on the ocean or the Great Lakes. And it is this reason on which particular emphasis is laid in Mr. Sweeney's paper. Mr. Sweeney shows the stern-wheel flat bottom steamboat to be superior to all other types of vessel for the navigation of our Western rivers, because of its enormous steering power. Some of the advocates of the Lakes-to-the-Gulf deep waterway scheme claim that if the Mississippi River had 14 ft. depth of water available for navigation from St. Louis southward at its lowest stage, there would then be sufficient depth at ordinary stages so that ocean steamships could ascend the river from New Orleans and land their cargo at the wharves of St. Louis. If any of our readers are favorably impressed with this proposal, we suggest a careful comparison of the steering power of the stern-wheel flat bottom steamboat, such as Mr. Sweeney describes, and that of the ordinary ocean-going vessel. In order to ascend or descend the Mississippi or any of its chief tributaries, a vessel must be able to stem a considerable current, and to do this great steering power is just as necessary as great propelling power.

In river navigation, a vessel must be able to keep its course in narrow channels, where a swift current is flowing. The river boat, with its large rudder, shallow draft and flat bottom can do this; but the ocean vessel, with its deep, narrow hull and small rudder, when traversing a narrow channel always tends to swing out of its course toward one side or the other and this tendency is particularly strong if there is any opposing current in the channel.

It is not at all difficult to understand why the ocean vessel in a narrow channel is so hard to steer. Imagine an ocean vessel traversing a narrow channel—a ship canal, for example. The water which it displaces is piled up at the bow and flows past on either side, and so long as the vessel is kept just in the center of the channel, the pressure of the two streams on the opposite sides of the hull are equal. But as soon as the bow swerves a little toward one side—say the left—the volume of the current on the opposite side and its pressure against the hull is increased, while the pressure against the hull on the opposite side toward which the bow has swerved is diminished. This unbalanced pressure tends to turn the boat still farther out of its course and the farther it turns, the greater the forces acting to throw it toward the bank.

For an object lesson of the difference in the steering power required to guide a flat bottom vessel and a deep hulled vessel, take a piece of 2-in. plank and push it up a channel in which a moderate current is flowing. When lying flat on the water the plank may represent a typical river steamboat or barge. When floating on its edge it may represent a deep-hulled vessel.

We offer these illustrations merely to make the problem clear to the reader unfamiliar with matters of navigation. To the marine engineer, however, the behavior of a deep-hulled vessel in a narrow channel is a matter of common knowledge. Pilots and ship captains understand perfectly well the difficulty of keeping a ship in a narrow channel, particularly when there is an opposing tidal current. They know very well how persistently a ship tends to run her nose into one bank or the other in traversing any narrow channel. It is this that has caused the Corinth ship canal to remain unused by shipping. It is this as much as the wash of the banks which keeps down the speed of vessels passing through the Suez canal to about 5½ knots. At low speeds, however, while there is less tendency of the vessel to veer toward the bank, the steering effect of the rudder is correspondingly small. We are informed that vessels in the Eastern trade, which regularly pass through the Suez canal, have holes in the rudder for bolting on an extension to the rudder blade to give greater steering power while passing through the canal.

We have thought it worth while to present the above facts, because of their important bearing on such questions as the much discussed one of sea-level vs. lock canal at Panama, and of allowable currents in channels traversed by lake or ocean vessels, as well as their bearing on the question of economic draft for river navigation.

Surely these facts deserve the careful study and fair consideration of those who are promoting the movement for inland waterway improvement. If river transportation can be carried on as economically with a draft of 6 or 8 or 10 ft. as with any deeper draft, why should untold millions be spent in the endeavor to procure 14 or 16 or 18 ft. on inland rivers?

Again, there is a popular impression (based largely on articles published in newspapers and magazines, by writers equipped with that little knowledge that is proverbially so dangerous), that the reason why river traffic in the West has fallen into decay is because the steamboats used there are not of the best design for economical transportation.

The argument has been widely used that because river transportation flourishes in Germany, therefore, the German models of river steamboats ought to be copied in the United States. Before such arguments are accepted by engineers, however, surely careful investigation should be made and accurate knowledge should be gained. Mr. Sweeney makes out a strong showing for the present type of Western river steamboat as a thoroughly economical machine for the conditions it has to meet. He speaks with the authority of long experience. We believe his discussion is an important contribution to the literature of waterway transportation.

LETTERS TO THE EDITOR.

The Effects of Cooling a Boiler Furnace.

Sir: I was surprised to see in an editorial note following my communication in your issue of April 14 that you disagree with me concerning the matter at issue in the University of Illinois boiler tests. I called attention to the fact that CO_2 was highest in the tests showing the greatest efficiency, and claimed that this fact must necessarily be very largely instrumental in producing a greater efficiency with the boiler under which it occurred. You appear to take an opposite view, as your statement is,

"These figures, which our correspondent claims are the cause and not an effect of the better results obtained by cooling the furnace, clearly support the argument of the Experiment Station Bulletin that *a certain amount of cooling of the combustion chamber of boiler furnace can often be secured without impairing the combustion appreciably.*" (Italics ours—Ed.)

It appears to be your opinion that the higher CO_2 was due to the furnace condition, or to the furnace temperature, when, as a matter of fact, the percentage of CO_2 is controlled entirely by the amount of air supply, a smaller air supply producing a higher CO_2 and a larger supply a lower CO_2. A condition wherein the CO_2 is highest will necessarily produce a higher temperature of combustion, because all the heat generated is present in the gases of combustion until imparted to the boiler. Likewise the amount of gas flowing from the boiler to the chimney will necessarily be smaller and consequently carry less heat. This is well known and recognized.

It is a fact that, in the tests in question, the gases leaving the boiler which showed the higher efficiency, were lower in temperature than the other, and for this there could be two causes. One is that the exposure of the entire one-half of the area of the lower row of tubes would extract enough heat to produce this result. The other is that the temperature of combustion was higher with the result that more heat would flow into the boiler, owing to this higher temperature of combustion. Now

we are confronted by the fact that the CO_2 was highest in the case of the boiler with the exposed tubes. Thus it manifestly is not wise to attribute the result to the enlarged cooling capacity of the boiler, in view of the fact that the report states that with the exposed tubes some smoke was made. This being true, it necessarily followed that there was some loss by incomplete combustion, with the boiler with the exposed tubes, on account of the escape of unburned gases, as evidenced by the smoke.

Personally, in view of the sincere and serious effort being made to eliminate the smoke evil, I think that all of the facts involved should be considered.

Very truly yours,

A. Bement,
Consulting Engineer.

2114 Fisher Bldg., Chicago, Ill., April 20, 1910.

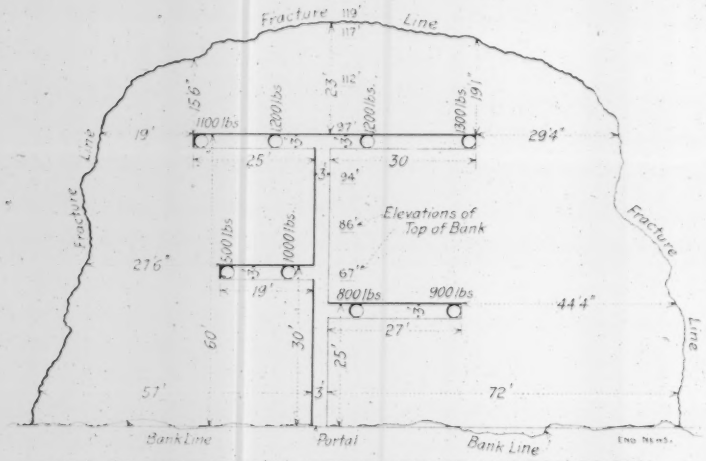
[The possibility of maintaining excellent combustion conditions, with a partially cooled furnace and combustion chamber, and of even increasing the over-all boiler efficiency without making appreciable or objectionable smoke is the real subject of Bulletin 34 of the University of Illinois Engineering Experiment Station, to which we called attention in our issues of March 17 and April 14. While traces of smoke were detected at the stack, analyses of the flue gases failed to show the expected condition of incomplete combustion. It was evidently possible even to improve the combustion by a slight decrease of air supply, though efforts were made to maintain the same draft conditions always.

We do not understand that those responsible for the tests in question have even regarded the slight increase of CO_2 noted (0.7% average) was a result of cooling the furnace but looked at it rather as a coincident circumstance showing that such cooling did not prevent excellent combustion. Moreover, it does not seem advisable to assume, as our correspondent does, that an increase in CO_2 of as little as 0.7%, an average of determinations at the uptake of a single brick-set boiler, is alone a safe guide in fixing the causes of increased efficiency.

The idea of decreasing the temperatures of the combustion-chamber walls to reduce the radiation and stack losses has been studied more or less for at least eleven years. Bulletin 34, in question, however, presents the most complete individual study we have seen of how to solve the problem without impairing combustion and without producing appreciable smoke.—Ed.]

An Effective Blast in a Quarry at Linnton Prison, Ore.

Sir: From a close review of years of past experience and all available figures and records that could be obtained, I believe a new record in rock excavation was established as regards the amount of powder used per cubic yard by the shot which was fired at the Linnton Prison stockade Feb. 19 by Multnomah County, Ore.



PLAN OF COYOTE HOLE FOR BLAST AT LINNTON PRISON STOCKADE, MULTNOMAH CO., ORE.

(54,800 cu. yds. of solid rhyolite were excavated and broken up. This gives a ratio of 6.85 cu. yds. of rock to 1 lb. of powder.)

Cross sectioning showed excavation of 54,800 cu. yds. of a solid basaltic formation commonly known as rhyolite, with a specific gravity of 2.78, or a weight of 4,691¼ lbs. per cu. yd., and this was completely excavated and entirely broken up with 8,000 lbs. of No. 2 Trojan powder.

It was the desire to shatter the formation as much as possible owing to the fact that it was all to go through a crusher, and the result showed excellent execution in every way, inasmuch as the rock will require scarcely any preliminary bull-dozing. This is the more remarkable in view of the fact that the formation ran rather heavy in iron pyrites, which naturally had the tendency to cement it more solidly together.

The shot was pronounced by a number of experts on the ground to be the best shot that had ever been seen made in this locality. The coyote hole was loaded under the direction of the writer, and the amount of powder used, as well as the proportions for each load, was precisely calculated, so that the formation did not raise or throw at all. The hillside simply tumbled over like a pile of snow. Another thing that is deserving of attention in this shot is the wonderful break-back, which is plainly shown in the accompanying diagram.

J. C. Costello, C. E.

Portland, Ore., April 4, 1910.

Reinforcing Concrete with Structural Steel Shapes.

Sir: The almost general adoption of the T-beam section in reinforced-concrete work, with its accompanying complex problems of horizontal shear, diagonal stresses, bond stresses, and location of steel for the resistance to those stresses, leads the writer to believe that a system of reinforcing that will accommodate any system of loading, and that will eliminate the usual high bonding stresses that are developed by the adoption of the proprietary bars now on the market, would be welcome to the engineering profession.

The general tendency of designers of reinforcing metal, up to the present, has been to select round or square bars, as basic elements of reinforcement, and combine with same, directly or indirectly, other bars, round or square, at varying angles with the basic elements, to compensate for the lack of shearing value of the concrete and, at the same time, to assist the bond between the steel and the concrete. Some proprietary bars have the subsidiary or shear bars a part of the basic or tension rod, others electrically weld them to the primary rod and in some systems of reinforcement the shear bars are loose stirrups, simply looped around the tension rods. The primary principle remains the same, however, and close investigation will show that round or square bars are almost universally used in reinforced-concrete work.

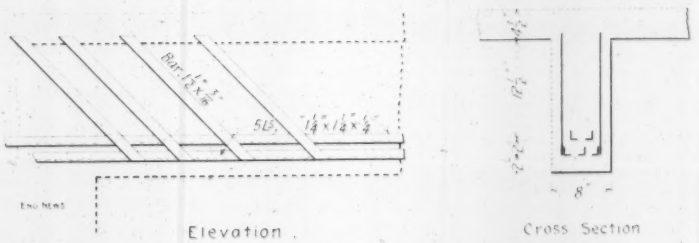
To carry this analysis of standard practice a little further, it will also be found that, in large T-beams, carrying heavy loads, rods of large cross-sectional areas, and consequently relatively small superficial areas, are the general rule.

The writer thinks that the bar which will give the cheapest and best reinforcement is one that has a maximum superficial area for a constant cross-section, providing it still retains sufficient rigidity to preclude too great a deflection for ordinary spans, due to its own weight.

Such a bar is, and always has been, right at hand, in the form of structural steel shapes, angles and T-bars. Not only do we find here the requisite superficial area, with the required cross-sectional area, but we secure the additional advantages of riveted connections of shear bars, increased rigidity over usual proprietary reinforcing shapes of the same cross-sectional value, and possibilities for more rigid connections at columns.

The additional advantage of being able to design special bars, under odd or unusual loading conditions, and to purchase them at the same unit cost as ordinary reinforcing rods, will appeal to all engineers who have attempted to meet such requirements with proprietary rods of standard design or else be under the necessity of calling for special rods at increased unit cost.

Such a method of reinforcing as I have attempted to describe is illustrated in the accompanying figure. Objections have been offered to the method there shown, on the grounds that the concrete would not fill the re-entrant angles of the angle reinforcement, and, consequently the required bond strength would not be developed. The writer, however, firmly believes that extended tests would prove this objection fallacious.



A SUGGESTED METHOD OF REINFORCING CONCRETE T-BEAMS WITH STRUCTURAL SHAPES.

In case continuity of beam construction is required, or desired, it may be secured by riveting a horizontal angle to top of shear bars. It will at once be apparent, in this case, that increased bonding strength is developed for the bar.

To summarize the advantages of the system:

(1) For the same amount of reinforcing metal, in weight, the total cost would be less, with the system suggested, than with any system now on the market, as the unit cost of structural steel is, of necessity, less than the unit cost of proprietary rods.

(2) Any desired placing of diagonal stress rods can be secured, at the same unit cost as the tension, or main, bars, which cannot be said of any proprietary rods now on the market.

(3) The exact and permanent location of all steel reinforcing is definitely known, providing steel angle reinforcing columns are used, with bolted connections for the girder reinforcing.

(4) A great saving in amount of steel is effected by the great number of available shapes, with slightly varying cross-sectional areas.

(5) The bond areas are such as to preclude all slipping of the bars, without depending on the diagonal stress rods or bars, thus allowing a maximum number of straight, standard shapes to be used.

(6) Each unit has greater rigidity for resisting deflection, due to its own weight, than any standard bars now on the market, with the same cross-sectional area.

(7) The bars would be sufficiently rigid, in most instances, to preclude the necessity for spacers.

(8) The designer would be enabled to design, to the minutest detail, all reinforcing metal, instead of being obliged to choose the bars from standard available forms, with predetermined location of shear bars.

Yours truly,

Joseph T. Maguire.

16th and Newton Sts., Washington, D. C., April 21, 1910.

[The idea of using structural shapes for reinforcing concrete has been put into practical use in a number of structures which, from time to time, have been described in Engineering News, but as a rule the shapes have not been so small as those suggested by our correspondent. There are two difficulties, or dangers, in the use of such small shapes; first, the possibility that the concrete will not flow entirely around the angular section of the shapes and thus decrease the bonding area, and second, the possibility of a low adhesion value of concrete to the flat surfaces of the shapes.

The first of these may be merely a matter of manipulation which can be corrected in careful work, but the second is a danger partially verified by tests. These tests, though limited in number, have been most consistent in showing that a flat plate, say ¼ × 1-in. in section, has a bonding value of about 60% of that of a square or round bar of the same cross-sectional area. If this same relation applies to an angle or T-bar, which are merely two flat plates joined together, the additional bonding area claimed for the structural shapes is balanced or overbalanced by the reduction in unit bonding value.

It is quite possible that the low unit bonding value found in flat plates is due to their tendency to wave or bend, in which case the application to structural shapes will not hold. At any rate the advantages of rigid unit treatment in structural shapes should warrant some tests being made to determine the relative strength of the method. —Ed.]

The Accuracy of Simple Methods of Leveling and Plumbing Walls.

Sir: The elaborate article in Engineering News, April 21, 1910, p. 458, by John T. Stewart, Assoc. M. Am. Soc. C. E., entitled "Tests of Simple and Inexpensive Surveying Instruments," seems to have left out one of the most necessary qualifications in the experiments, viz.: the personal equation. It makes a material difference, not wholly in the simplicity of instruments used, but far different results come from the individuality of the user. I well recollect in my boyhood days watching a stone mason leveling up a cellar wall, by using a common carpenter's square, placing it so that one arm was vertical at the side of the wall, and tieing a chip of stone to a cotton cord for a plumb bob, and pushing a bit of stone under one end of the horizontal arm until the vertical arm was plumb. He had no trouble in getting a plane that would not vary more than a quarter-inch out of true level by sighting along the horizontal arm. Many of the Italians who have recently come to our shores have furnished object lessons in laying out cellars and digging ditches to grade by simple and inexpensive methods. If the writer of the article mentioned will carefully examine many of the carpenters' and builders' levels in use, he will find a surprising accuracy when used by the workman. They get results; it is necessary only to test a perpendicular wall to prove the point.

Individually, I am a disciple for the best and highest grade of instruments used in engineering, but not a believer in many of the methods used, or taught, for accomplishing many purposes.

W. M. P. Shelton.

Burlington, Iowa, April 25, 1910.

Criticisms on Customary Reinforced-Concrete Construction.

Sir: Where abstaining from hair-splitting, the numerous points of criticism set forth by Mr. E. Godfrey in your issue of March 31, 1910, p. 358, seem to be very well taken and to point in the right direction.

Two of his criticisms especially should find recognition and ought to determine further developments; first, that the customary reinforced concrete is hampered by shrinkage strains and, second, that the uncertainty regarding the coefficient of elasticity makes the use and computation of statically indeterminate structures hazardous.

In metallic structures, conditions requiring the application of the theory of elasticity have been avoided in this country as far as practicable, although the coefficient of elasticity is fairly constant and reliable; why then should a much more serious difficulty be introduced in the methods of reinforced concrete, where all demands for beauty may be otherwise satisfied?

Shrinkage strains certainly should be avoided. This can be accomplished, and the cost of construction can be cut down considerably, at the same time keeping the design within safe limits.

With respect to beams and trusses, Mr. Godfrey has justly pointed out the great security and simplicity of anchored round rods for tension, which, when slightly bent upwards at ends, will alone take care of all the shearing stresses. Compare this arrangement with the complicated systems of deformed trussed rods with their stirrups and other accessories, and these anchor rods will appear cheap and handy.

The next step will be to leave the anchor rods straight and to tighten them up during the setting and hardening of the concrete, thus doing away entirely with the shrinkage strains. The action of this beam is then exactly the same as that of an ordinary plain concrete arch. The friction is sufficient to take care of all shearing stresses save in very exceptional cases, such as very short but exceedingly heavy trusses. The practicability and ease of this method of construction has been borne out by tests.

Very respectfully,

Charles R. Steiner.

P. O. Box 214, Gridley, Cal., April 18, 1910.

THE MARYLAND STATE ROADS COMMISSION proposes to build 187½ miles of improved roads during the present year, distributed through 22 counties.

A Long-Lived Bridge of Perishable Material.

While steel bridges are the rule on railways in most parts of the United States, there still remains in northern New England a considerable number of wooden bridges whose construction dates back to the early days of the railway era. A correspondent has forwarded us two recent photographs of one of these bridges, located on the Concord & Claremont Branch of the Boston & Maine R. R., and they are reproduced herewith.

As seen in the interior view, the bridge is a composite structure composed of a wooden lattice truss, or "X-bridge" as it was commonly called, which is strengthened by a heavy wooden arch built up of flat planks sprung to the required curvature. It must be admitted that these old wooden bridges have had a useful life far in excess of that of the early iron and steel bridges. The cost of maintenance, too, is comparatively small, if the trusses are kept well protected from the weather. Nevertheless, wooden bridges on a railway are always liable to be set on fire by a passing locomotive.

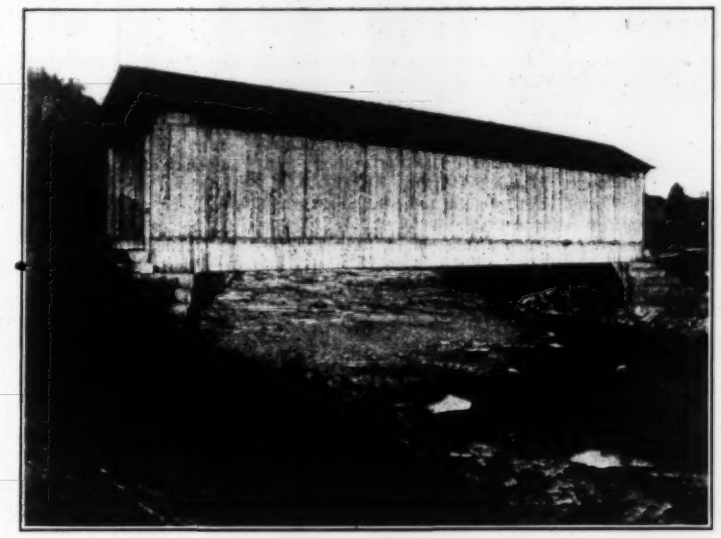


FIG. 1. A WOODEN BRIDGE ON THE CONCORD & CLAREMONT BRANCH OF THE BOSTON & MAINE R. R.

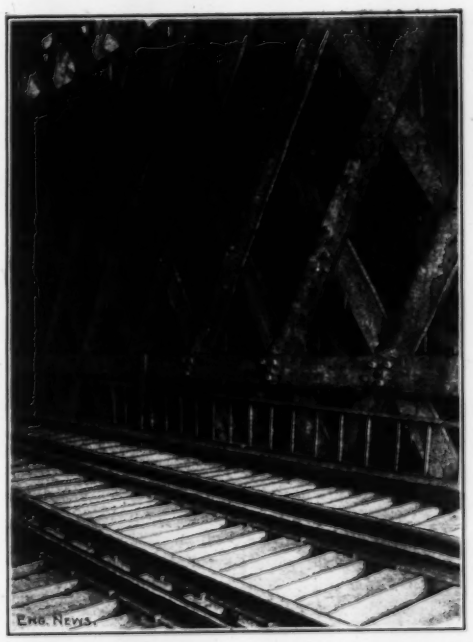


Fig. 2. Interior View of Railway Bridge, Showing Wooden Lattice Truss and Stiffening Arch.

There is always a chance that such a fire may start and weaken some vital part of the bridge before discovery, and that a serious wreck may result. This reason alone is sufficient to cause the abandonment of structures of this type, and a few years more will doubtless see the last of them replaced.

The Raldiris Bill for Licensing Engineers in New York.

The Municipal Engineers of the City of New York referred the Raldiris Bill, now before the New York legislature, requiring a license for the practice of civil engineering in the State of New York, to a special committee. The report of that committee was as follows:

To the Board of Directors of the Municipal Engineers of the City of New York.

Gentlemen:

The committee appointed to represent you in the matter of the bill now pending before the Legislature relative to licensing engineers, begs to report that they are of the opinion that a suitable plan governing the issue of a license to practice engineering is to be commended, but that the bill now under consideration is objectionable in many particulars, among which they would cite the following:

1. The definition of engineering is entirely too narrow and has been so drawn that it might be construed to include men occupying subordinate positions.

2. The definition of an engineer is not qualified in such a way as to relate only to those who act in a responsible capacity.

3. It is unreasonable to enact a law which would not take effect until 3½ years elapsed, or to make provision for the appointment of an examining board 2½ years before the license is required. This treatment may be taken as evidence that there is no occasion for hasty legislation.

4. All examiners, other than the members of the first board, should be licensed before being eligible for appointment.

5. The minimum age limit for candidates for licenses should be greater than 21 years, and each such candidate, irrespective of his educational equipment, should have had at least two years' experience in a subordinate capacity.

6. The educational provisions of the bill are unsatisfactory in many particulars, among which might be noted the unnecessary recognition given to correspondence schools and a lack of clearness in the definition of educational standards.

7. It is inadvisable to recognize any examining body other than the one specially created for this purpose.

8. The bill does not distinctly specify that four examinations annually should be held in each locality.

9. The bill contemplates a license to be issued "according to the qualifications of the applicant," while the act otherwise provides only for a general license.

10. The bill, in so far as it relates to the issue of licenses to those engaged in practicing engineering on the date when it becomes effective, should not stipulate the duration of the course given by the engineering schools whose degree is to be recognized and it should not provide for the issue of licenses to those practicing engineering and who have not received a degree, excepting in cases where the applicant has had at least five years' experience, of which one has been spent in responsible charge of engineering work.

Under these conditions your committee recommends that the bill in its present form be opposed, and that the Society cooperate, in so far as practicable, with other recognized engineering organizations to the end that a suitably modified act may be prepared for submission to the next legislature.

Signed by the Committee.

April 26, 1910.

The above report was approved by the Board of Directors and recommended to the Society for its approval. Such approval was voted at the meeting of the Society on April 27, and the President, Mr. Arthur S. Tuttle, was authorized to appoint a committee of six to represent the Society and to cooperate with other engineering societies in this matter.

A special committee was appointed by the Council of the American Society of Mechanical Engineers at its meeting on April 12 to advise the Council what action the society should take with reference to pending legislation to restrict the practice of engineering.

At a meeting on April 27, this special committee adopted resolutions that the Council request the New York Assembly to postpone action on the pending bill until after the spring meeting of the society at Atlantic City, where the subject will be discussed. It was also resolved that any legislation affecting the status of engineers can be most wisely framed by conferences between the legislators and representatives of the national engineering societies, and the Council was advised to appoint a committee of five to consider any legislation affecting the interests of members of the engineering profession.

Sanitary Condition of Inlet Tunnel Water Supplies Immediately after Completion.*

By JOHN W. ALVORD and LEWIS I. BIRDSALL.†

This subject suggested itself in connection with the new municipal water-supply at Gary, Ind. The water is obtained from Lake Michigan through a concrete tunnel 6 ft. diameter and approximately three miles long. The intake crib is located in 41 ft. of water at a distance of 1½ miles from shore.

The usual precautions had been taken in the contract and by inspection to insure a minimum amount of pollution during the construction of the tunnel, but nevertheless there was unavoidably a certain amount of pollution from both men and animals. This was indicated only by an odor of ammonia, noticeable in the tunnel after its completion, the tunnel having been carefully cleaned, plastered, swept and washed in accordance with contract requirements.

Mr. Alvord was convinced that the water which was to pass through the tunnel would be contaminated for a considerable time, and that a serious responsibility rested upon the engineers in putting the tunnel into use prematurely. He was unable to find that in tunnels similar to that at Gary, more than the ordinary cleansing methods had been used, nor were there on record any suspicions as to the purity of the water-supply received for the first few weeks through tunnels similarly situated. After thoroughly canvassing the situation, the engineers decided to turn the water into the tunnel, flush it thoroughly, and watch results closely by analytical methods.

A laboratory was established and frequent bacteriological tests were made, both of the water in the lake (immediately over the intake crib) as well as the pumping station. The results of these analyses are shown in the diagrams, Figs. 1 and 2. The daily pumpage is also shown at the top of each table, so that the relation between the amount of water passing through the tunnel and the bacterial content of the water can be observed. The average daily pumpage for domestic purposes at this time is only 400,000 gals. The storage capacity of the tunnel is approximately 3,200,000 gals. It therefore requires from seven to eight days for water to pass from the intake to the pumps under the ordinary conditions of pumpage.

Lake water was turned into the tunnel June 24, 1909, while the pumps were not started until July 1. The water in the tunnel during this period, therefore, remained at rest and the bacteria had an opportunity to increase in number. The sample of water from the shaft showed 15,000 bacteria per cc. on June 30, as compared with 125 in the lake water at the crib. B. coli were absent in both samples. From July 1 to 5, 10,000,000 gals. of water (or three times the storage capacity of the tunnel) was passed through the tunnel each day. The bacterial count immediately decreased in a marked degree, but was much higher than that of the lake water. The presence of B. coli was indicated in a large number of the samples from the shaft. The amount of water pumped daily from July 6 to 14 inclusive, averaged 5,000,000 gals., or nearly twice the storage capacity of the tunnel. During this period the average number of bacteria per cu. cm. of tunnel water were nearly the same as from July 1 to 5, but B. coli were practically absent. The lake water showed a very small number of bacteria and no B. coli.

A temporary water-supply at Gary had been derived from shallow driven wells in the sand, while the construction of the permanent inlet was under way. After July 14, lake water only was supplied to the city. The amount of water pumped daily from July 15 to 20, inclusive, was the amount of the domestic consumption only, or approximately 400,000 gals. daily. The number of bacteria in the tunnel water on these days rose to a maximum of 200,000 per cc., while B. coli were shown

*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, held at the University of Illinois, March 8, 9, 1910.

†Alvord & Burdick, Consulting, Hydraulic and Sanitary Engineers, 1212 Hartford Bldg., Chicago.

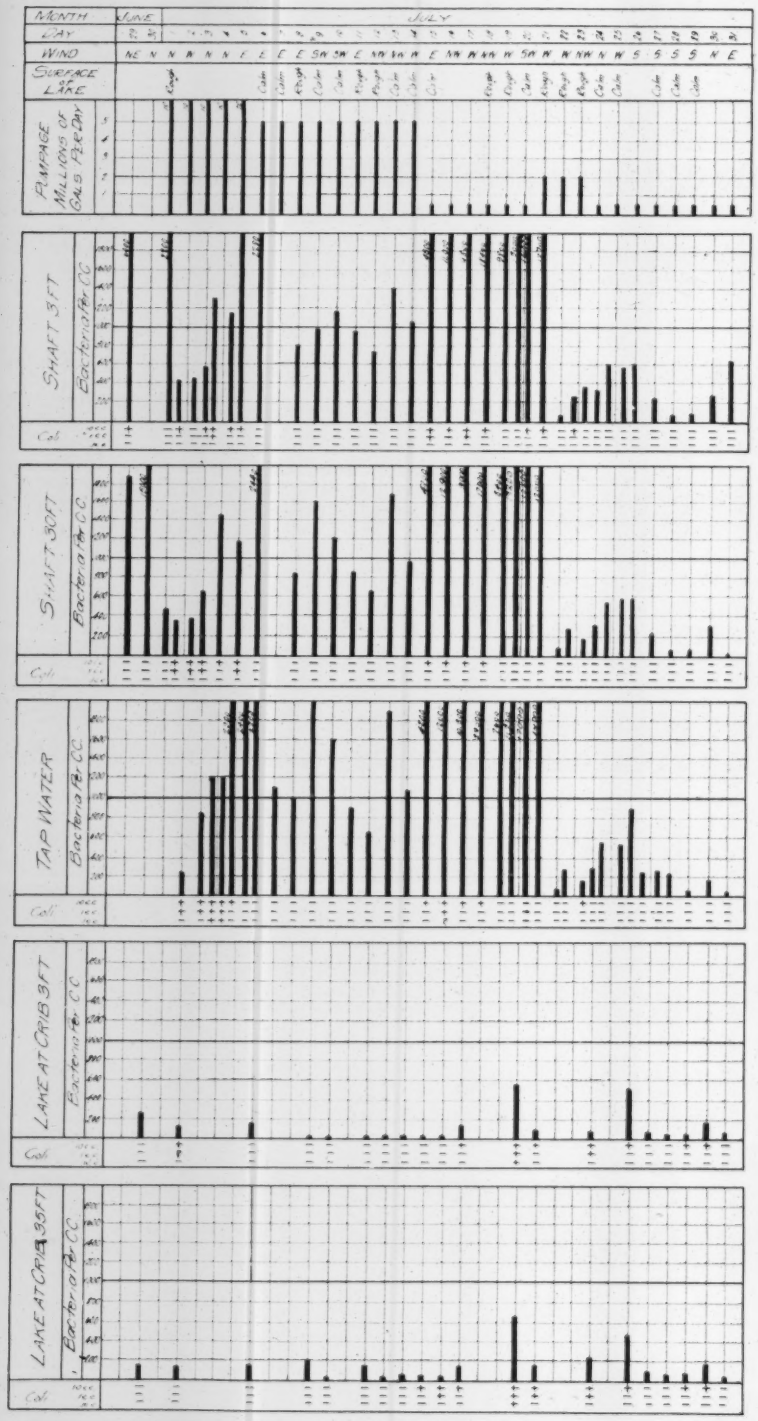


FIG. 1. BACTERIAL ANALYSES OF WATER FROM LAKE MICHIGAN, SAMPLED AT THE INTAKE AND SHAFTS OF THE WATER TUNNEL; GARY, IND. (JULY, 1909).

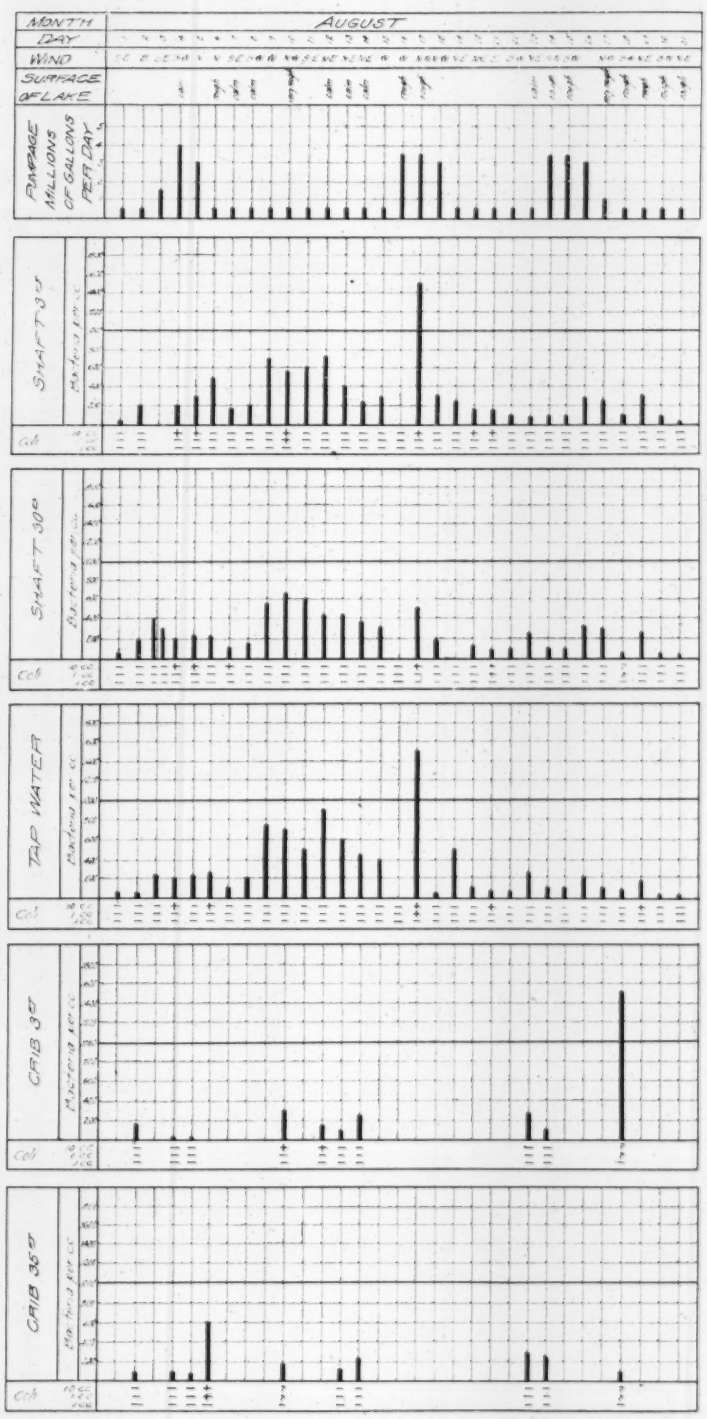


FIG. 2. BACTERIAL ANALYSES OF WATER FROM LAKE MICHIGAN, SAMPLED AT THE INTAKE AND SHAFTS OF THE WATER TUNNEL; GARY, IND. (AUGUST, 1909).

to be present in a number of samples. The lake water continued to show satisfactory bacterial counts, although B. coli were present in several of the samples. Great increase in the number of bacteria occurred during the passage of the lake water through the tunnel.

From July 21 to 23, the amount of water pumped was increased to 2,000,000 gals. per day. The bacterial content of the tunnel water showed an immediate decrease while B. Coli were shown to be absent in all samples. The number gradually decreased during the latter part of July, and continued fairly low during the month of August. Occasionally the presence of B. coli was indicated in the tunnel water, but in most of the samples B. coli were absent.

Judging from the data for July and August, as given above, it appears that with all the ordinary precautions for keeping the work of construction free from pollution and with the application of the methods ordinarily used for purifying a tunnel after its completion, an inlet tunnel of this character may still be grossly polluted and capable of contaminating a city water-supply. In the case of the Gary tunnel, it required a period of 21 days and a total pumpage of 100,000,000 gals. of lake water for flushing the tunnel before the construction pollution in the tunnel was shown to have been removed, and the water was made safe for domestic use.

In view of the considerable expense in pumping this flushing water, it would probably have been more economical to effect the sanitary requirements with a disinfectant such as hypochlorite of lime, prior to filling the tunnel. This plan was considered but rejected in favor of the flushing, owing to lack of time to prepare, and perhaps a failure to appreciate the amount of flushing necessary.

Owing to the nature of the construction, it was impossible to introduce a disinfectant into the lake shaft during admission of the water. A plan was considered, however, of introducing hypochlorite of lime into the tunnel by means of paper bags suspended from the roof, at intervals of about 500 ft. before water was turned in, it being expected that the water would soften the paper and release the chemical, thus uniformly dosing the water after the tunnel had been filled. It would probably be impracticable to apply the disinfectant directly to the floor and walls, as in filling the tunnel from the lake end, the chemical would be washed to the shore end of the tunnel, and the water would be unevenly dosed.

At the time the work was done, some search was made through technical literature to find what precautions had been taken in other similar work in the numerous water tunnels that had been constructed upon the Great Lakes. No evidence could be found, however, of any record of especial precautions to protect the sanitary character of the water furnished immediately following construction.

A New Water Pressure Regulating Valve with Electrical Quick-Opening Attachment.

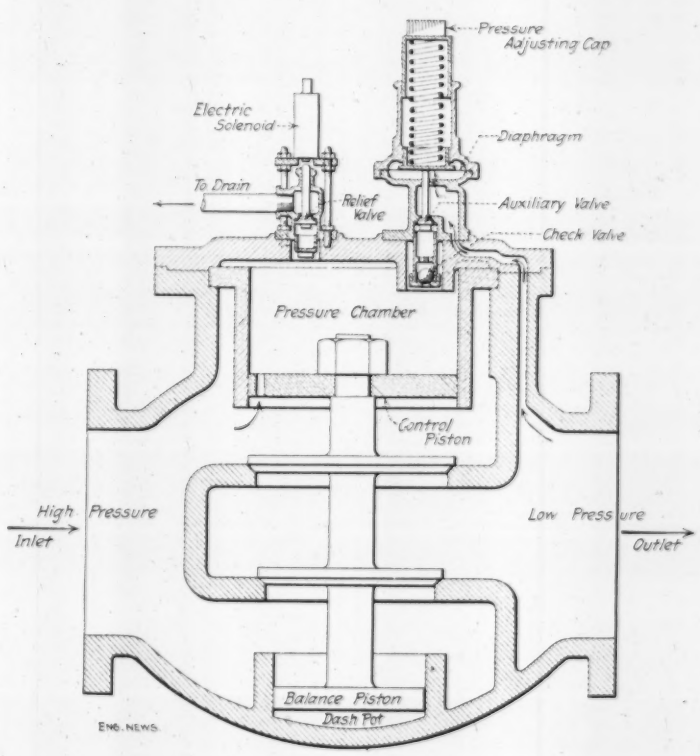
The valve shown in the accompanying sectional view is designed to maintain a definite lower pressure in pipes supplied with water from high-pressure mains. Such a valve is required, for example, when a high-pressure service is reduced to low pressure for domestic distribution. The valve shown is fitted with an electrically operated quick-opening attachment for use whenever the full pressure is needed in the low-pressure pipe system, as in case of fire.

PRESSURE REGULATION.—The essential principle of this valve is the same as that of other pressure regulating valves* made by the same company (the Golden-Anderson Valve Specialty Co., Fulton Bldg., Pittsburg, Pa.), although the application differs in details and the arrangement of parts. The pressure-controlling element is the helical spring, mounted in a bronze sleeve on the top of the valve bonnet at the right, which presses down on the upper side of the diaphragm. The under side of the diaphragm is subjected to the water pressure on the low-pressure side of the main valve. The water reaches the diaphragm through a small port cast in the valve body at the low-pressure side, as shown in the illustration.

The pressure of the spring can be adjusted by screwing in or out the threaded cap enclosing its upper end. When the water pressure on the diaphragm falls below the spring pressure, the diaphragm is depressed and pushes open the small auxiliary valve. This opens the passage from the small low-pressure port to the pressure chamber above the control piston on the upper end of the main valve stem.

The main valve stem is shown in its closed position in the illustration. The pressure chamber is filled with high-pressure water which enters it through the small port (at the left) through the piston. When the auxiliary valve is pushed open by the diaphragm, water from the pressure chamber escapes through the auxiliary valve and the small port into the low-pressure piping. As fast as the water escapes from the pressure chamber, the control piston is forced up by the water pressure beneath it and carries with it the valve stem, thus opening the main valve.

High-pressure water then passes through the main valve to the low-pressure side until the pressure on the under side of the diaphragm overpowers the spring and permits the auxiliary valve to close. The water in the pressure chamber thereupon reaches the pressure on the lower side of the control piston and the main valve is closed by the excess pressure on the top of the upper valve disk. The balance piston and dash pot at the lower end of the main valve stem assist the control piston in steadying the motion of the valve and in cushioning its closure.



ANDERSON WATER PRESSURE REDUCING VALVE WITH ELECTRICAL QUICK-OPENING ATTACHMENT.

QUICK-OPENING ATTACHMENT.—A second auxiliary valve is mounted beside the regulating auxiliary on the top of the main valve and effects the quick-opening referred to in our first paragraph. The opening of this second auxiliary, or relief, valve is effected by closing a switch at the pumping station or fire station. When current passes through the solenoid, its core is drawn down and opens the relief valve by pressing on the valve stem. The pressure-chamber water then escapes through the relief valve to the drain pipe and allows the control piston to rise and open the main valve wide regardless of the position of the first auxiliary valve. The opening of the relief valve puts the regulating auxiliary temporarily out of action.

The normal operation of the valve is restored by simply opening the switch which cuts off the current through the solenoid. The core is at once returned by a spring to the position shown in the illustration and the relief valve closes. The main valve then returns to the regulating position.

*One of these was described in Eng. News, March 12, 1908, p. 288. Other types of water pressure regulating valves were described in Eng. News, Dec. 28, 1905, p. 688.

Flood Losses in Missouri.*

The destruction in Missouri during each flood year is enormous and startling. Until the first of August, 1909, no effort had ever been made to compile statistics showing the financial loss in Missouri from floods. In order to convince the land owners that a concerted movement should be made to protect their land from the heavy floods, this department began then to compile figures to show that it was time for action. To secure reliable information, blanks were sent to conservative men in the various counties of the State where floods occurred during July, 1909, and the results of this special investigation in the 43 counties above the Missouri River and the ten counties bordering on the south side of the river, are herein given. The reports showed that a total of 1,485,280 acres of land were overflowed last July in these 53 counties, and that the crops destroyed were worth $18,896,340.

The destruction in many counties was extremely heavy, while in others it amounted to only a few thousand dollars. Howard, Livingston, Carroll, Daviess, Atchison, Chariton, Grundy and Holt counties reported losses ranging from $500,000 to $1,500,000. Howard County headed the list, with a loss of $1,500,000; Livingston County was second, with $1,200,000, and Grundy, third, with $1,059,840. Daviess lost a round million dollars; Carroll, $960,000 and Holt, $825,000.

The loss in the Missouri River bottom, because of the 1909 overflow, was not so great as that of 1908. This was because many farmers were able to thresh and haul their wheat from the lowlands in 1909 before the flood, which came about the middle of July. The 1908 overflow caught the farmers just before wheat harvest, and destroyed all the crops except on a few high points. The same was true of the flood of 1903. Had the 1909 rise come ten days earlier, the loss along the Missouri River would probably have been augmented at least three million, if not five million, dollars.

The estimates secured for this report place the destruction to crops along the Missouri River alone at $8,629,750. The destruction in 1903 and 1908 being each greater than that of 1909, it is evident the loss to the farms along the Missouri River for each of these years has averaged at least nine million dollars. Supposing three overflows occur during every ten years, the destruction in that time will amount to $27,000,000 and in 37 years, which is an average life time, it will reach the enormous sum of $100,000,000.

The foregoing figures represent only the crops that were destroyed, and do not include the amount of loss caused by soil and fences being swept away, and other property damages.

The channel of the Missouri River, from the Iowa line to the river's mouth, north of St. Louis, is said to be about 575 miles long. This indicates the loss each flood year to every mile of river channel amounts to $15,600, or $46,800 during ten years, and $140,400 during 30 years. The average cost of constructing new channels for small rivers and building levees will not exceed $15 per acre of land benefited. The average loss in one flood year is from $18 to $25 per acre.

The floods by no means were confined to the north part of the State, for many counties through which the Osage River runs experienced heavy overflows. Bates County, near the head waters of that river, had many thousand acres flooded and valuable crops were destroyed. St. Clair, Henry, Dade, Johnson, Camden, Polk and other counties in that part of the State each lost crops worth from $25,000 to $300,000. The valleys of the Gasconade River being narrow, the overflow land along it is not extensive, except in a few places. The greatest destruction usually occurs in Osage and Gasconade counties, but many farms in Maries, Pulaski, Phelps and Laclede counties, along the Gasconade River, suffer extensively.

*From "Draining and Leveeing Missouri Low Land," a Supplemental Report of the Bureau of Labor Statistics of Missouri for year 1910.

An Emergency in the Life of a River.*

By ROBERT S. TAYLOR.†

What follows is in the nature of a brief for the Mississippi River. This discussion will be confined to facts relating to the main trunk below Cairo. There are here two distinct interests to be served—the improvement of the channel for navigation, and the protection of the alluvial land from overflow, which will be referred to separately, beginning with the latter.

Protection From Overflow.

If we take into account all the facts—the area of the protected lands, their fertility, the peculiar value of their products, the cost of the work which has been done, the interests which depend upon it now, and its promise of future usefulness, we are bound to say it is the greatest and most beneficent work of reclamation ever undertaken in the world.

The area of land subject to overflow in a state of nature is 29,790 sq. miles—equal to five-sixths the area of the whole State of Indiana. Its reclamation began 200 years ago, at New Orleans, and continued slowly and painfully up river for 150 years with only interrupted and partial success. During the Civil War the levees were practically abandoned. After its close their reconstruction was undertaken, but with such small success that great floods went through them and over them without restraint.

It was only when the Mississippi River Commission was created in 1879 and the United States came to the aid of the people that real progress was made. The policy of the Commission from the first was to help those most who helped themselves most. Under this stimulus the people, as a rule, did their utmost. The grand result has been that since 1882, when the first United States money was allotted for levees, about 232,487,000 cu. yds. of earth have been put into the embankments; $22,562,544 expended by the Government, and a much larger sum by the people through their State and local organizations, but which cannot be accurately stated, for which we have to show 1,487 miles of levees, which have withstood the floods and protected the valley with substantial completeness for ten years past.

The system as it stands to-day is the result of this cooperation since 1882. The feeble little lines which existed before that date have been washed away or buried under the embankments which have been built over them. The work is just beginning to demonstrate its value. The people are alive with new hope and confidence. Railroads are threading the valley as thickly as in New England. Property values have advanced enormously. The work of surface drainage is under rapid headway. In a few years this whole area will have no waste land in it. The abandonment of the levee system is no more to be thought of than the abandonment of New York Harbor or the Panama Canal. And if it is not to be abandoned, the only sensible thing to do is to maintain it in as perfect security and permanence as possible. How is that to be accomplished?

While, as stated, the lines have been effective in holding all floods for a number of years with substantial completeness, they are not yet finished. The utmost safety and usefulness of the system will require the expenditure of a few millions of dollars and three or four years' time yet. Until that shall have been accomplished, the cooperation of the General Government and the States will have to continue along the same lines as in the past.

The time is near, however, when the maintenance of the levees can be turned over to the people who live behind them. This transfer has begun already. The Upper Yazoo Levee District has maintained its own lines along its entire front of 115 miles for four years, and has expended in that time $2,344,600. Some other districts are pretty nearly ready to go it alone likewise.

These statements have reference, however, only to the maintenance of the levees—the embankments themselves. They do not include the maintenance of the banks on which the levees stand. If the people are to take care of the levees, the Government will have to take care of the river. The caving bends work their way to the base of the levees and undermine them. It has had that habit ever since there were levees to be undermined. But the greatly increased height of the floods since they have been confined to the channel, and the correspondingly increased height of the levees necessary to confine them have introduced a new necessity for the restraint of this bad propensity.

A crevasse is always a serious disaster, but it makes a world of difference whether the water goes through with a head of 5 ft. or 15. The usual course in the past has been to retreat when a caving bend threatened a levee, and build a loop farther away from the bank, connecting with the old levee at safe points above and below. This is not difficult when the embankment is low and the ground favorable; but there are situations in which it is nearly impossible. Sometimes a threatened levee stands on a narrow strip of land between a river and a lake, so that further retreat is impossible without going around the lake, which may require many miles of new work, and involve engineering difficulties practically insurmountable. In such a case it is often good economy — sometimes absolute necessity, to arrest the advance of the caving bend by revetment of the bank. This word covers any kind of work to stop caving. On the River Rhine, in Germany, it is commonly a stone wall, or sloping pavement. On the Mississippi it is a combination of brush mattress and stone riprap. The mattress is made from willow brush woven into a fabric two or three hundred feet wide, a foot and a half thick, and a thousand feet or more in length, which is laid on the underwater surface of the bank, reaching from the low-water line to the toe of the slope. Above the low-water line the bank is graded to a flat pitch and covered with a thick riprap of loose, broken stone.

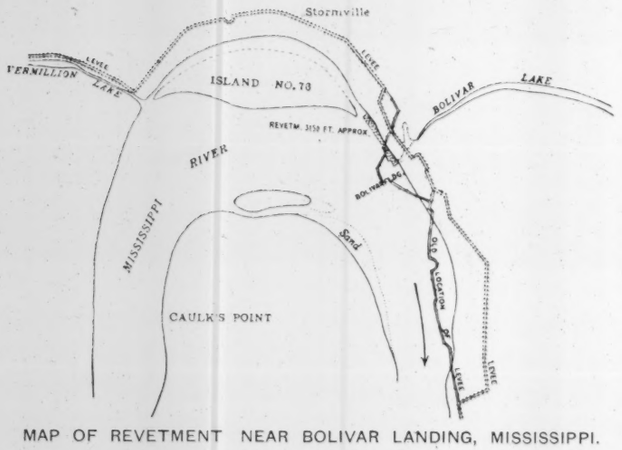
The making and placing of these huge brush mats is an art which has reached its highest development on the Mississippi River, and has attracted the attention and admiration of engineers all over the world. It has reached its present perfection as a result of over thirty years of costly effort and experiment. The main object of this paper is to point out its utility on the Mississippi River and the urgent necessity which exists at the present time for carrying it forward on a more extensive scale than heretofore.

To facilitate understanding of the facts to be presented, several maps of typical localities where revetments have been built, or are needed now, are inserted, upon which descriptions of those places will be based.

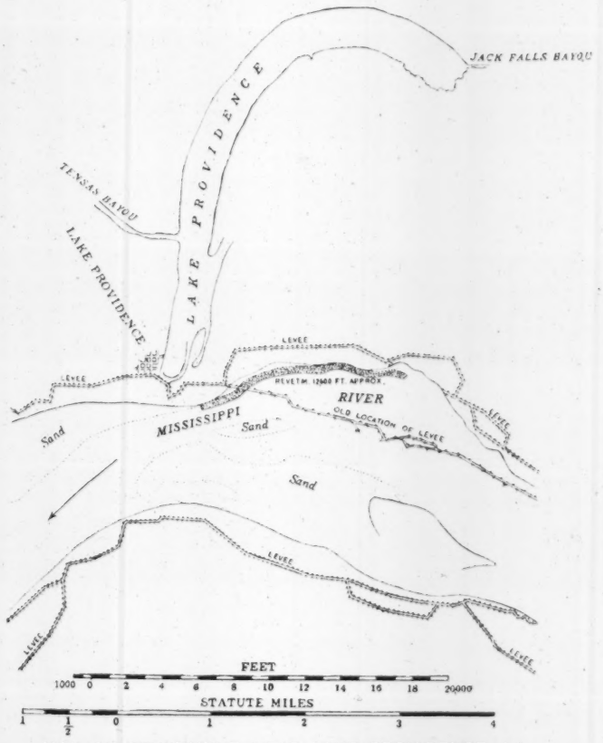
BOLIVAR REVETMENT.—The first revetment built for the protection of a levee was at Bolivar Landing, in Mississippi, 418 miles below Cairo, in 1888. The accompanying map shows the situation. The cartographers' symbols are almost self-explanatory. The double jagged line marked "levee" denotes the existing embankment; the double line with lateral, thorn-like projections at intervals denotes the location of a former levee now either undermined and washed away, or lying idle upon the bank; the unbroken black line is the present river bank, and the honeycombed cross section is the revetment of brush mattress and stone riprap placed against the bank.

The levee here was a heavy, costly embankment standing on a neck only a few hundred feet wide between a rapidly caving bank and the head of Lake Bolivar. A branch at that point would have made it necessary to build a new line many miles in length around the lake and across the bayou at its foot. The revetment was undertaken as an experiment in a desperate emergency. It was a surprising success. It held the bank and has to this day. The great levee stands exactly where it stood when the first mattress was laid 21 years ago. The original work has had extensive repairs and has been extended downstream about one-half of its original length. Its present effective length is about 3,150 ft.

LAKE PROVIDENCE REVETMENT.—A similar, but still more serious situation, developed at Lake Providence, La., 540 miles below Cairo, a map of which is inserted, which speaks for itself. The city of Lake Providence was at the head of the lake of that name, and immediately behind a levee standing on the margin of the lake within a stone's throw of which a caving bank was advancing with great rapidity. To lose the levee was to lose the city and be compelled then to build a new line around the lake and across two bayous. Encouraged by the previous success at Bolivar, work was begun here in 1894. It has had extensive repairs and upstream extensions until it is now nearly 2½ miles long, but it has done its work well and has been a good investment. The long line of old levee location shown on the map where once stood a flood-defying embankment which has been swallowed up by the river is a grim testimonial to the relentless march of a caving bank.



MAP OF REVETMENT NEAR BOLIVAR LANDING, MISSISSIPPI.



MAP OF REVETMENT NEAR LAKE PROVIDENCE, LA.

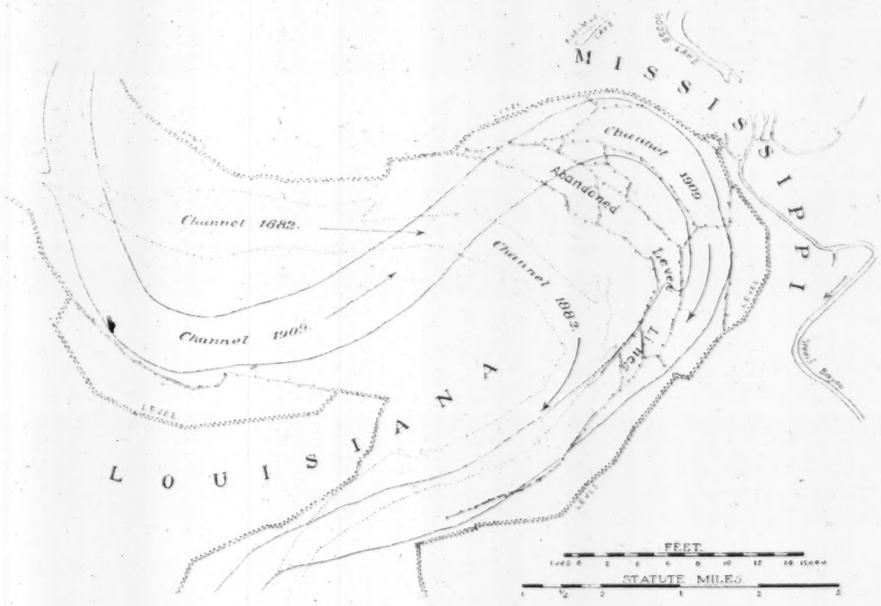
ALBEMARLE BEND.—The map of Albemarle Bend, in Mississippi, between Greenville and Vicksburg, shows a place where nothing has been done as yet in the way of revetment, but where something must be done without delay to avert disaster. This map goes into more detail than the others, and carries the history of the changes further back. The fine dotted lines show the location of the river in 1882, and the unbroken black lines its location at present. It appears to have crossed its own path three times since that date. The network of abandoned levee lines shows the long struggle which has been kept up to get away from the advancing bend by building loop after loop; and the lakes and bayous outside the present levee show that that struggle has reached its limit. It is necessary now either to stop the caving by revetment, or build a new line extending far back into the country around lakes and across bayous at an enormous expense and in the face of extreme engineering difficulties.

This map of Albemarle Bend is a picture of what will

*From "Professional Memoirs," Corps of Engineers, U. S. A., Jan.-March, 1910.

†Member of the Mississippi River Commission.

take place in bend after bend in the Mississippi River if that lawless stream is allowed to have its way. It would be extravagant, perhaps, to say in all of them, and yet hardly so if we give the river time enough. The maintenance of the levee system under the burden of such frequent and never-ending renewals of the present costly embankments would be hardly possible. Even if the cost could be borne, such a system could not command the confidence necessary to high and enduring prosperity. The community would be like an army encamped upon a plain in a hostile country without means of defense and liable to attack at any moment. The people would be subject to incessant alarms. The exigency presented at Albemarle Bend has its parallel at several other places on the river now, and they will develop year by year elsewhere until all the actively caving bends shall have been securely protected.



MAP OF ALBEMARLE BEND, MISSISSIPPI RIVER.

THE GREENVILLE BENDS.—We have here in one map the most interesting reach of the river, and one containing two of its most important revetments, besides a third of less importance, and the locality presenting just now the most emergent necessity for another. Speaking of bends, here they are—one of the finest examples of nature's engineering which the world has to show; so majestic in their sweep, so symmetrical in their curves. Guided by no compelling feature of mountain or rock, they look as though they had been laid out with intelligent purpose to establish the equilibrium of forces on which the stability of the channel depends.

This long sentence requires an explanation. The flowing water in the channel has a certain erosive force, depending on its velocity. The bank has a certain resisting strength, depending on the material of which it is composed. When the erosive force is relatively greater, the bank caves. A caving bend tends to return upon itself, and by and by it cuts off its own neck. This shortens the river by the difference between the distance across the neck and that around the bend. This produces an increase of velocity for a distance above and below the cut-off. This increases the caving action. This extends the bends, and so lengthens the river and reduces its velocity and diminishes caving. And so, through ages and ages past, the Mississippi has vainly tried to find some equilibrium between the velocity of its current and the strength of its banks which would give it stability. It finds this condition in increasing degree as it nears its journey's end, as a man finds peace in his old age. In the lower reaches of the river its slope flattens out and its velocity diminishes, while the banks are formed of finer sediments than those deposited in the upper reaches, and have greater strength to resist erosion. As a consequence, caving is less active and the river is straighter.

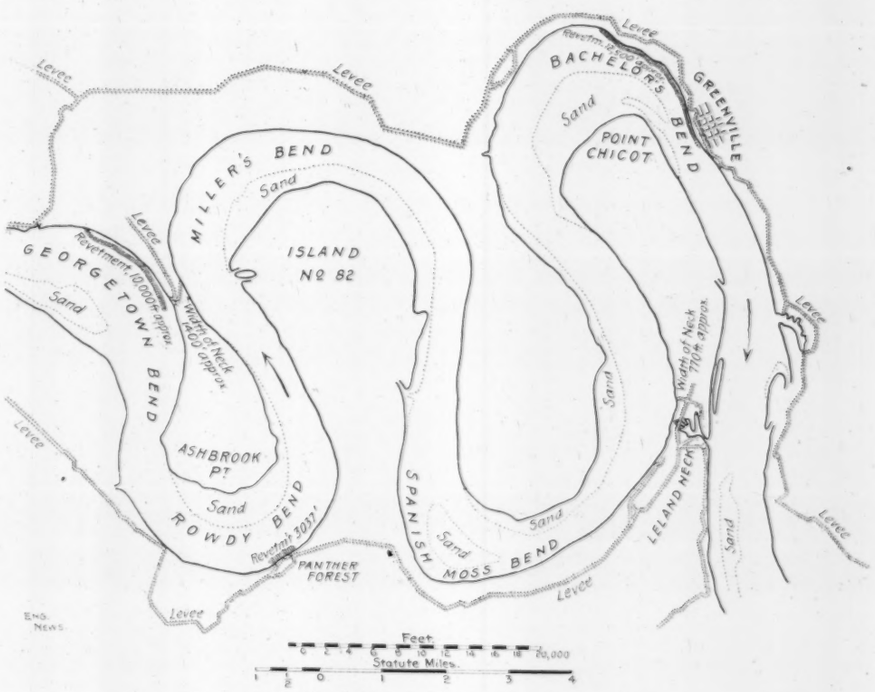
The Greenville Bends lie in the region of active bend making and neck cutting, as the numerous crescent-shaped lakes in that part of the valley testify. Those are all abandoned bends left inland by cut-offs. The Greenville Bends are very old. Since a time when the memory of man runneth not to the contrary they have, until recently, maintained through their graceful curves their even flow and a good channel. But the inevitable cycle of change has overtaken them. As long ago as 1888-9 the neck connecting Ashbrook Point with the Mississippi shore had reached a dangerous stage of attenuation. With four such great bends following one another in immediate succession, each with a narrow neck, a cut-off at the upper one could hardly fail to be followed by like disasters at the others. They would all let go in quick succession. Such a disturbance of the river's regimen as would be produced was never known. The suddenly liberated stream would run riot and play havoc with its banks and everything on them in all that country. To guard against such a disaster a revetment was begun at Ashbrook Neck in 1890, and has been maintained in effective condition, and extended from time to time until it now holds nearly two miles of bank front. It is in good condition with every promise of permanence. There is no doubt that it has been worth many times its cost.

After many years of stability the bank in front of Greenville began to cave actively in 1882. By 1894 the total recession amounted to 4,000 ft. While this was going on, in 1887, a spur dike revetment was placed in front of the city. This is a form of bank protection consisting of projecting spurs or dikes at intervals along the bank. The river promptly flanked the dikes and went on with its work, leaving the dikes standing out the channel. In 1891 the standard brush and stone revetment was substituted, and has been maintained since with upstream extensions, as needed, and is at present about 12,500 ft. long, and in good condition with promise of permanence. It has undoubtedly saved the city of Greenville from destruction and the levees in that vicinity from an experience like that shown on the map of Albemarle Bend.

At Panther Forest, in Rowdy Bend, is a new revetment put in a year ago to protect the levee at that place. The point of greatest interest now, however, in the Greenville Bends is Leland Neck. This neck has been shrinking slowly for several years, but only within the last year set up the somewhat unusual and dangerous action of cutting upward from the lower side. The map shows the irregular pockets which have formed. These are not very deep, but in the case of a heavy overflow across the neck would be dangerous. Levees have been built, as shown on the map, to guard against that overflow. But the situation requires a revetment and the urgency for it is very great.

A revetment was begun in 1887, at Cowpen Neck, immediately above the city of Natchez, to prevent a cut-off at that place. It has been extended progressively as necessity demanded until it now covers 21,848 lineal feet of bank in two detached sections, with an unprotected gap between them of 1,400 ft., which requires revetment to make the work complete. That the cut-off would have taken place but for this work is certain, and that the damages would have been many times the cost of it is equally certain.

At Walnut Bend, Ark., 281 miles below Cairo, a caving bend has been working its way for a good many years toward the St. Francis River, threatening, if unchecked, to cut off a considerable section of the lower end of that stream. It is necessary to leave open the foot of each of the large basins like the St. Francis (which contains about 6,000 square miles) for the escape of surface water into the Mississippi. A cut-off by the Mississippi River into the St. Francis at Walnut Bend would give that river a new mouth, expose all that part of the basin lying below to inundation and flood the basin with backwater for many miles upstream. A revetment has been begun and is in progress there to guard against that disaster.



MAP OF GREENVILLE BENDS, MISSISSIPPI RIVER.

Improvement of the Channel for Navigation.

The only obstacles to navigation in the Lower Mississippi are the sand bars. There is an occasional snag, but they have ceased to be the terror they once were; they make no serious trouble any more. The natural depths over the bars often go down to 4 or 5 ft. during the low-water season. By the work done under the Mississippi River Commission this was first increased to 8 ft., and then to 9 ft. by annual dredging, which latter is the depth now named in the law. This is accomplished by a fleet of nine hydraulic dredges at an expense of about $250,000 per annum, or something over, exclusive of the original cost of the dredges.

It is assumed here that the popular movement in the United States for the development of internal waterways has serious meaning, and that it will take practical

shape in the not distant future. When it does, the line from the Great Lakes to the Gulf will be the chief of them all. That part of it lying below the mouth of the Ohio will certainly follow the channel of the Mississippi. In view of this probability—certainty, almost—the subject of revetment has an interest and importance independently of its relation to the preservation of the levees. The talk is of a 14-ft. channel. Some suggest more, but no one less. To maintain a channel 14 ft. deep down the main stem of the Mississippi will be possible, and by means similar in a general way to those by which the 9-ft. channel has been obtained, but they must be far more thorough-going and effective.

The present channel is 250 ft. wide; the 14-ft. channel will have to be 500 ft. wide. To make the present channel, the cut across a 5-ft. bar need be only 4 ft. deep; to make the deeper one it must be 9 ft. deep. The cross section of one cut is 1,000 sq. ft.; the cross section of the other will be 4,500 sq. ft. At low water the bars act as dams between pools above and below them. Such large cuts through those dams will tend to lower the upper pools. This in the aggregate will tend to lower the whole low-water surface of the river. This will bring up bars heretofore submerged too deeply to obstruct navigation, which will also require dredging. The whole low-water discharge of the river will go downstream more rapidly than now. This will tend to drain the pools. That will require deeper cutting to maintain the navigable depth. This shows how foolish people are who talk about a ship channel to St. Louis unless they propose to dig it and hold the water in it by locks.

To maintain a 14-ft. channel by dredging, it will be necessary to begin the work long before the water falls to that depth—say, when it falls to 24 ft. or earlier. It will also be necessary to transport the dredged material a much greater distance than at present. One of the difficulties of the work as carried on now is the tendency of the sand to run back into the cut. The deeper cut will increase that tendency. It will be necessary to deposit the sand farther away from the edge of the cut. This, with the increased quantity to be moved, will greatly augment that part of the work. The cuts will also have to be much longer, because the bars, as a rule, have flat slopes. Undoubtedly there will be difficulties attending the greater width and depth of the cuts that cannot be foreseen. Such a one suggests itself in connection with the broader bottom of the cuts. With a width so great as 500 ft. the river may take a notion to amuse itself, as it does in crossing its natural bars—by wandering about and making subsidiary channels here and there. No one can tell just what it will do in that situation. It will also be more difficult to make good any accident, or slip, or delay which may occur. We are bound to anticipate that the 14-ft. channel will carry a great commerce. It will not do to have it full of dredge boats.

The difficulty of the problem is in the quantity of sand to be taken care of. It is easy to handle a little of it, but there is a point at which the undertaking would become impossible. To a traveler on the Mississippi at low water the most interesting feature of the landscape is the sand bars piled up along the channel, 10, 20, 30 ft. high, miles in length and thousands of acres in area. Where does the material in them come from, and how does it get there? It comes from the caving bends above, from which it is transported only a short distance, to be deposited as soon as and wherever the current falls off in its velocity.

The Mississippi River is a great freight carrier. It classifies its freight to a nicety. It carries some fine sediments from the Missouri River to the Gulf of Mexico. Some coarse stuff it rolls along the bottom out of the bend and up the next bar, to leave it there. Intermediate between these it lifts, floats, pushes, or rolls the particles according to their specific gravity and the velocity of the current at the moment. But by far the greater part of the material which forms its bars is moved only a short distance. If the caving were stopped, the bars would speedily shrink to small proportions. This is the way to a 14-ft. channel-revetment of the banks to reduce bar building to a minimum, and dredging for the balance.

A little the most economical way to cover all the caving banks would be to begin at the head and work continuously downstream. But that is not greatly important. Revetments can be put in here and there where most needed without great sacrifice. Practically the work can be done in no other way. It will take many years to reach a 14-ft. channel, even if we begin now with that specific depth in view. It will necessarily come progressively, foot by foot, partly by dredging, and, if we proceed wisely, partly by revetment. Both forms of work will be the mere continuance of work now going on, only on a larger scale—more plant, more men, more money. We will not, at least we need not, for some years to come, build any revetments for the sole purpose of deepening the channel. Each one will serve a double purpose—to protect a levee line; to prevent a cut-off; to improve a harbor; to save a city, or the like, and, at the same time, contribute to the diminution of bar building and the final fixation of the bank with that complete control of the river which the people of the United States will secure sometime whether we in our generation help or hinder.

As has been stated, the popular demand so far has been for 14 ft. from the Great Lakes to the Gulf. The adverse report on that scheme by the Board of Engineers appointed by Congress to consider it, which has been made public, may or may not influence the attitude of the advocates of the project. But it must be reckoned with. And in view of it the friends of waterway improvements may well consider whether it is necessary to lay so much stress on 14 ft. or any particular depth. The vital end to be reached is to develop waterways as a supplement, or addition to the railroads of the country in handling its transportation; as many of them as will be useful and as capacious as will be profitable. The argument rests on the economy—the absolute, unchangeable, everlasting economy of water transportation; its immediate economy in freight costs, and its large and far-reaching economy in consumption of coal, wood and iron, and the conservation of natural resources. As compared with these considerations the apparent demand, or want of a demand, to-day on the part of shippers for waterway facilities ought not to be controlling.

It is a disappointment to us all that commerce has not taken advantage of the increased channel depths in the Mississippi from St. Louis to New Orleans as they have been developed within ten years past. But the reasons are not far to seek. The first is the uncertainty of their permanent maintenance. They depend upon annual appropriations by Congress. Those are liable to fail. They have failed occasionally in the history of the work. It would take millions of dollars to equip the Mississippi River for the commerce it is now ready to carry. Capital hesitates. This hesitation is not unnatural in view of the history of the work. Thirty years ago the Mississippi River Commission started out with large promises of an improved channel. We were to have 8 ft. from Cairo down in short order. We did not get it. We had the art of revetment to learn. Miles of our work failed. Years and years were spent in experiments—not supposed to be experiments at the time, but experiments as results proved.

Such experiments are very tedious and long-drawn. It takes a whole season to put a revetment in a bend. If it holds through the next flood, good. If through the next, better; if the next, still better. But the proof is not yet. It may do all that and then fail. When it goes out, what was the reason; did the river get under it at the inner edge and dig out a cave behind it into which it slid? Sometimes. Did the water from some inland lake or swamp seep through the sand layers behind it and wash out a cave under it, or soften the soil so that the whole bank, revetment and all, sloughed into the river? Sometimes. Was the structure of the mat too stiff and unyielding so that it would not fit itself to the curvature of the bank? Sometimes. Was it too limber, so that the current doubled it up? Sometimes. Was there a lack of sufficient stone to hold it down? Sometimes. Often and often these questions were asked, and years were spent in answering them. Numerous revetments were built and rebuilt over and over. Congress became so disgusted that at one time it forbade the further use of revetments. But it repented of that folly two years later.

At last the problem seemed to have found a solution. The fascine mat now used very rarely fails. It has stood all the tests for fifteen years. But with its stone riprap it costs $30, or a little more, per lineal bank foot. Our original estimate was $12. And it swallows up willow brush at a fearful rate. At the darkest day of these discouraging experiences invention gave us the hydraulic dredge capable of moving sand at the rate of thousands of cubic yards per hour. It has given us the 9-ft. channel. It is not strange that commerce became discouraged. The steamboats and dredges in use wore out. Their owners hoped to build larger ones to utilize the improved channel and waited. When they got tired of waiting they turned to other enterprises.

Another reason why commerce on the river lags is that people are afraid of the railroads. It is a curious circumstance that under the law as now administered, a railway may lawfully cut rates to any extent to meet the competition of water transportation, as though that mode of conveyance were a thing to be outlawed and destroyed, if possible. It may not give a special rate to a shipper unless he is in situation to ship his goods by water; then it may. It is worth considering whether that favoritism ought not to be stopped.

Another reason why commerce delays to improve its opportunity on the Mississippi River is that for ten years past there have been so many inviting fields of business elsewhere. It is the same thing that makes it hard to man our merchant marine with American sailors. There are too many better jobs on land. River navigation waits on the initiative of individual men. Each man accommodates himself to existing conditions. If the railroads overcharge him he grumbles, but pays the rate. If his business suffers from delay in transportation, he puts up with it. It will take some strong, courageous, optimistic man, or group of men, to make a start in the navigation of the Mississippi below Cairo. Once started on a foundation of confidence it will grow.

If there were a channel 10 ft. deep from Chicago to New Orleans to-day with public confidence in its permanence, it would be crowded with boats within ten years. If we postpone work for a "demand" and discover no demand until we see men standing on the bank with money in their hands, there will never be any improved waterways. God Almighty did not wait for a demand from commerce before He made the Great Lakes.

Everybody is afraid of the Mississippi River. The people who live in its alluvial valley are afraid of its floods; steamboat men are afraid of its bars. The inhabitants are just beginning to take courage. The water has been held at bay for ten years. But an extraordinary flood, a few bad crevasses and the inundation of 4,000 or 5,000 square miles would plunge them into a despair again from which it would take a long time to recover. We have had a 9-ft. low-water channel below Cairo nearly all the time for a little less than ten years. But it has not been entirely trustworthy. There have been some slips in the management of the dredges and some bars have gotten ahead of us for a few days a few times. Not often, nor for long, but enough to keep alive the sense of uncertainty. So men who would build big boats to navigate it wait, and keep waiting.

There is a wiser way which our fellow-citizens of Kansas City are taking. They have organized a million-dollar corporation there to construct and operate on the Missouri River a line of freight boats adapted to navigate its shallow channel just as it is. They are to have low decks, light draft, ample motive power and every feature of construction to accommodate them to the conditions which exist in the Missouri, just as the Germans have done on the Rhine. They have enlisted the services of experts to design a steel boat for the purpose and they expect to make it go and make it pay, and they will. That is the way to get there—turn your face in the right direction and start.

We shall have, or ought to have, in this country some day an infinite ramification of navigable waterways, from the little ones, with their shallow motor boats, to the lordly Mississippi, with its broad, stable, improved channel somewhere from 14 to 20 ft. deep. We will not run ocean vessels or lake vessels in our rivers and canals, but boats suitable to them. We shall develop the art of freight handling and terminal facilities to the point that will reduce the cost of transfer from boat to boat, or boat to land, to an unimportant amount. With our waterways, our railways, and our trolley ways combined, we shall beat the world in transportation, as we have in everything else. Between the present and that consummation, however, are years of study, experiment, discussion and preparation. Only at one place are we ready to proceed now with work that will have its useful part in the final scheme, whatever form that may take, and that is on the banks of the Lower Mississippi.

It would be worth while to do it if there were no alluvial valley to protect—just to build up confidence and lead the way to the large improvements to come. But when we take into account the levees, the lives and property and prosperity which depend on them, the money which has been invested in them, the disasters which would attend their destruction, and the indispensableness to their preservation of the same revetments which will contribute to the improved channel we have a case of emergency the statement of which more words would weaken rather than strengthen.

What is needed—and that is the point to which this brief is directed—is no great sum of money at once, but something like two million dollars a year in addition to the usual past appropriations for the Lower Mississippi in some form of regular and unfailing provision for five or ten years to come.

A SUPERANNUATION SYSTEM for civil servants in Canada has been recommended by the Committee on Civil Service Administration of the Canadian Senate. The committee declares that a system of superannuation is not only desirable, but absolutely necessary in the public interest. It favors the principle of contributions by the beneficiaries, and offers a bill providing for the retirement of civil servants between the ages of 60 and 70. The Government may order the retirement at 60, and the servant may retire of his own motion at 65. The retirement becomes compulsory at 70. The act, if adopted, would affect a large number of engineers in the government service.

A CONFERENCE ON UNIFORM WATER-WORKS ACcounts and reports will be held at the New Willard Hotel, Washington, D. C., May 24 and 25, 1910, under the auspices of the U. S. Bureau of the Census. Various state water and public utility commissions have been asked to send representatives to the conference, and an invitation to attend has been extended to any and all interested in water-works accounting. Further information may be obtained from Mr. L. G. Powers, Chief Statistician in charge of Statistics of Cities, Bureau of the Census, Washington, D. C.

Annual Meeting of the American Water Works Association.

The thirtieth annual convention of the American Water Works Association was held at New Orleans, La., April 26 to 30. Considering the remoteness of the meeting place for most of the members, the attendance was large. No qualifications need be placed on the thoroughly representative character of the membership in attendance. The program was less full of papers than those of the past few years, but that was in many respects advantageous. The meeting as a whole was considered a notable success.

Prof. Wm. P. Mason, of Troy, N. Y., remarked, in his presidential address, that as between the presentation and discussion of technical papers and the informal interchange of personal opinions the latter was the more important function of such a convention. He spoke of the desirability of permanent headquarters, a water library and a research bureau, all for the benefit of members. He referred specifically to a scheme now on foot by the George Washington Memorial Association for a building in Washington, D. C., to be occupied by scientific societies. As became apparent later on (see committee reports) the financial condition of the association gives no hope for permanent headquarters in the near future.

Papers and Discussions.

ELECTRICITY IN WATER-WORKS PUMPING.—Mr. Chas. B. Burdick, of Chicago, reviewed this general subject and presented facts and figures regarding a number of installations. For the most part the paper was based on personal experiences.

At Gary, Ind., producer gas is used to generate electricity to drive four 5,000,000-gal. pumps. Two of these pumps are for domestic service and work under 75 lbs. head. In case of fire the two fire pumps act as boosters to the others, adding 50 lbs. pressure. At Niagara Falls contracts for current to drive pumps have been made with two companies: one for regular service, the other for emergencies, only. Four miles of underground conduits are used in an important factory in electric pumping. Various plants near Chicago were also described.

MUNICIPAL IMPROVEMENTS AT NEW ORLEANS.—Mr. Geo. G. Earle, General Superintendent of the New Orleans Water and Sewerage Board, gave an interesting and impressive account of the water-works, sewerage, drainage, paving and other improvements successfully carried out by the city in the last ten years or so. These have involved a complete system of water-works, with pumping, purification and distributing systems; likewise a sewerage system de novo, as well as the reconstruction of an old, small and inadequate surface and sub-surface drainage system, with many pumping plants. The various improvements have already cost some $37,500,000, and it is expected that $25,000,000 more will be expended within the next few years.

WATER METERS.—Two papers dealt specifically with water meters. The first, by H. B. Rudisill, of Anniston, Ala., told how the Anniston Water Supply Co. managed to install meters against the legal opposition of the city authorities. The State courts decided that while the rates for water were fixed in the contract (flat rates) yet the contract contained no authorization of waste, and that the company had a right to charge for water used or wasted in excess of a reasonable quantity. The company then began to install meters and had placed about 250 in the sidewalk when the city council passed an ordinance prohibiting the disturbance of sidewalks to set meters. By this time the metered consumers had found that meters lowered rates and entered a protest against a return to the flat-rate system. This brought the council to a state of willingness to permit the universal meter system. At present all consumers are metered. With an increase of 25% in number of consumers since Jan. 1, 1906, the water pumpage has been reduced from 3,000,000 to 1,500,000 gals. a day, the coal consumption from 8 to 5 tons a day, the pumping staff from five men to three men and the hours of station operation from 24 to 12 per day. The revenue was temporarily reduced but is now greater than ever before.

Practical experience in the care of water meters was detailed by Mr. A. W. Cuddeback, of Paterson, N. J. The author believed meters of too large size are used, particularly for domestic service. The control of the meter should be in the water department. Meters should be tested every time they go to the shop, beginning when they are new. Each meter should be given individual consideration, in the light of its service conditions. In Paterson each meter reader has an audiphone, for the detection of water flowage not registered by the meter. It is of great importance to have experienced meter readers. They may well be encouraged to continue in service by liberal salaries. No meter reader should read the same meter twice in succession. Changes in route are an aid to accuracy in readings. The meter routes under Mr. Cuddeback provide for reading 110 to 150 meters in eight hours, with an average of say 120; all meters are in cellars.

THE SPRINGFIELD WATER-WORKS.—Mr. Allen Hazen, of New York City, described the new water-supply works of Springfield, Mass., with the aid of lantern slides. He also showed some Panama Canal views and heartily endorsed the way that work is being carried out.

CONSERVATION OF POTABLE WATERS.—Secretary Diven urged that water companies and municipalities alike take a long look ahead both for securing ample supplies and to guard against contamination. State regulation and conservation would be more efficacious than local action. Rival claimants for water were said to be hydro-electric plants, irrigation works and inland waterways. Of these the first seems to be the most serious. The author endorsed forest preservation and re-forestation and urged measures to prevent the further contamination of public water-supplies.

THE COST OF FURNISHING WATER.—Mr. Daniel W. Mead, of Chicago and Madison, Wis., sent a paper which led to much discussion. The author set forth the now quite generally accepted principle that water rates should produce a fair return on capital, provide for depreciation, for operation and maintenance, and yield a reasonable profit. Most of the paper consisted of a review of an attempt on the part of the city of Chicago, a few years ago, to compel a water company in an annexed district to reduce its rates to the level of those charged by the city. An analysis of the costs and revenues of the company and of the city showed that the company was entitled to higher rates than those charged by the city, and the courts so held. Finally the city bought the plant. The analysis mentioned also showed that the city was losing money on its water-works on account of not making sufficient allowance for capital charges.

Mr. A. P. Folwell, New York City, said comparisons of rates charged by cities and companies are unfair. In support of the assertion he stated that the latest U. S. Census bulletin on statistics of cities (1907) shows that of 137 municipal plants in the larger cities of the country only 12 were operated at a profit in 1907. This conclusion was reached after reducing the financial operations of the various works to a comparable basis, in accordance with the Census plan for that purpose, which plan includes allowances for capital charges, taxes, and various items generally ignored by cities, but which are essential for comparative purposes.

A member from Minneapolis said that he had maintained that the water-works of that city are losing $200,000 a year, instead of making the profit claimed. A firm of accountants has been employed to ascertain the facts. Mr. John W. Alvord said the common belief in Chicago is that the city water-works are a money maker, but many cost items are left out of account. For one thing, the water mains have been paid for largely on the assessment plan and interest charges are ignored.

Mr. Dabney H. Maury, of Peoria, said that a consumer might pay a small water bill and then pay two or three times as much more out of pocket to make up for deficiencies in his water-supply, as in the purchase of bottled water for drinking, extra fire department charges and extra insurance rates. Mr. Dow R. Gwinn, of Terre Haute, Ind., cited an instance of a man who had boasted of his low meter rate but who admitted on inquiry that he paid $36 a year for bottled water. Several speakers endorsed the plans of the U. S. Census Bureau and of the Association's own committee for uniform water-works accounts and reports.

A COOPERATIVE WATER-WORKS FRANCHISE.—Mr. John W. Alvord presented a water-works-extension franchise modeled largely on the Chicago street-railway settlement franchise (described at length in Eng. News, March 10, 1910). The ordinance was prepared by Mr. Alvord and Mr. N. A. Partridge, a Chicago Attorney, for Lake Forest, Ill., in 1908. Although suggested by the city officials it has not been adopted by them because it appeared that the company would be entitled, under the proposed ordinance, to a slight increase in rates.

The proposed ordinance provided for a determination of the value of the physical property of the company as of Jan. 1, 1908, by three disinterested hydraulic engineers chosen by the city and the company jointly, "no one of whom shall be considered nor shall be the representative of the interests either of the said city or of said company." In like manner either the city or the company could call for a readjustment of the rates once in any given year. Provision was made for the purchase of the works by the city at any time at the capital valuation already mentioned, plus additional capital invested for extensions.

The proposed ordinance stipulated that the city might determine what part of the income of the company should be paid by the city itself and what part by private consumers, the relative parts to be one-third and two-thirds, respectively, until otherwise fixed.

The rates in toto were to provide for operation and maintenance; a surplus fund to "pay for all necessary replacements and renewals;" interest on the capital investment (rate to be agreed on); the annual sinking fund payments which at 3% compound interest would make up an amount equal to the capital value of the works, with additions, thirty years after the date of the franchise.

Any surplus income after making the payments indicated would be divided equally between the city and the company. The sinking fund mentioned would be paid to the company at the end of the 30 years, whereupon the works would become the property of the city. In event of purchase, before the expiration of the franchise, the then amount of the sinking fund would be deducted from the amount to be paid by the city for the works.

An annual financial report by the company to the city, proper audit of accounts and city control over water-main extensions were also provided for.

MUNICIPAL OWNERSHIP.—Sensible remarks on this subject were sent to the convention by Mr. Park Woodward, until recently general manager of the city water-works of Atlanta, Ga. Mr. Woodward's conclusions were that the only way to run a municipal plant successfully "is to eliminate politics absolutely, and pay no attention to public criticism." Where this is impossible private ownership would be "better and safer," provided the companies could be so controlled as to prevent their charging excessive rates.

FIRE SERVICE WATER-WORKS, WINNIPEG, MAN.—A special fire-protection system, installed in 1907-8, was described by Mr. H. N. Ruttan, of Winnipeg. Water is taken from the Red River. Local conditions led to the use of producer-gas engines, with a reserve connection with the city gas mains. Six Crossley, two-cylinder, tandem engines, four of 540 and two of 250 HP. each, drive six triplex, direct-acting pumps.

There are eight miles of 20 to 10-in. mains, and 85 fire hydrants. The total cost of the system was $943,925, divided as follows: land, $58,550; buildings, $179,141; river intake, $28,913; machinery, $396,003; distribution system, $226,055; miscellaneous, $10,311; engineering and interest (estimated), $44,948.

CREOSOTING ALGAE.—Mr. Willcox, of Meridian, Miss., volunteered an account of an unusual way of dealing with algae. The water supply is from an impounding reservoir 23 acres in area and 18 to 2 ft. in depth. For three years past 1 gal. of creosote per acre of reservoir surface has been admitted to the reservoir early in the spring. If algae appear during the season creosote is sprinkled over the areas affected. The creosote has a specific gravity of 1.06 to 1.07, but parts of it are higher, penetrate only a short distance below the surface and then come to the top. Creosote is in better favor locally than copper sulphate because it is commonly taken in the South, and that in larger doses proportionately than are applied to the water. From the reservoir the water goes to a coagulating basin, where it receives 0.3 to 0.5 grains of sulphate of alumina and then passes to mechanical filters.

PIPES UNDER RAILWAY TRACKS.—Mr. Willis B. Durlin provoked much discussion by a brief paper describing his experience in pipe work under railway tracks. The city formerly protected the tracks in such cases, but a few years back the railway people expressed a preference to do this. This was allowed and much heavier track protection followed. After a while the railway began sending bills. These the water board has refused to pay, on the ground that the company was merely protecting its own property. Mr. Durlin appeared to be of the opinion that the city should bear at least part of the expense.

Both the paper and the long discussion that followed showed great diversity of practice in such cases in various cities, with rulings of more or less legal force on each side.

FORMULAS FOR MAKING WATER RATES.—After laying down some of the items which he thought should enter into charges for water, Mr. J. W. Ledoux described a hyperbolic and a straight line formula for determining meter rates in accordance with certain guarantees which he believed might well be required of consumers. The net results were sliding scales of rates. For instance, the consumer who guaranteed to use $1,000 worth of water per year was given a meter rate much less than one who agreed to use only $50 worth.

ASSESSMENTS FOR WATER MAIN EXTENSIONS.—Mr. Spaulding, of Springfield, Ill., raised an extended discussion on this subject. His city is up to its bond limit and devotes one-fourth of its yearly water revenue to extending mains. He thought the cost of extensions should be assessed on the frontage. By this means, he urged, the consumer would make one payment for main extensions and have done with it, whereas now they never cease making such payments. The discussion at this and other times during the convention brought out the fact that a number of north central and northwestern cities levy assessments for the cost of extending mains, including Chicago, Minneapolis and St. Paul. In the latter city, 10 cts. per front foot per year is paid for ten years, but, Mr. John Caulfield remarked, few people know anything about it, as the amounts are collected in the annual tax levy. At Minneapolis, the cost of mains up to $1.40 per lin. ft. is assessed on the frontage. Several speakers were opposed to water-main assessments, some holding that the cost of water mains should be capitalized like other construction costs, and others arguing that the practice is unfair, and that it is not comparable with assessments for sewers and pavements, because those who pay such charges are not also called upon to pay for the yearly service rendered.

There was also much discussion at this point on guarantee of revenue and advances of cost of new mains until such times as the extensions earn a revenue. The Baltimore County Water & Electric Co., Mr. Weber stated, makes real-estate developers deposit $1 per ft. of pipe extensions, and credits $50 per house using water on the extensions. When the credits equal the deposit the latter is returned, but deficits at the end of five years are forfeited. No interest is allowed. In another city, the full cost of extensions must be deposited in advance. When the revenue on the extension equals 25% of the cost of the latter the deposit is refunded, without interest.

A common practice seems to be to require a guarantee of revenue equal to 10% of the cost of the extension, but one or two members were emphatically of the opinion that this is insufficient.

QUESTION BOX.—This box was well filled, but few answers were forthcoming. One member said he had seen a hydraulic joint-calking machine at work and that it broke every bell tackled. This was offset by Mr. Alex. Milne, of St. Catherines, Ont., who said that after seeing one in most satisfactory operation in a sister city he had concluded to use one on four or five miles of 24 and 20-in. pipe.

The life of water mains in salt marshes was the only other question from the box that elicited useful information. Mr. J. M. Diven said that at Charleston, S. C., cast-iron pipe with its top at tide level has an average life of about 20 years. Sooner or later pipe under such conditions becomes so soft that a knife could be pushed through it. Others gave similar experiences, without specific life. One speaker said the only thing to do is to carry pipe over salt marshes on pole supports.

DANGER OF WATER CONTAMINATION WHERE SPECIAL FIRE SERVICES AND CITY MAINS ARE INTERCONNECTED.—Mr. Alex. Milne, of St. Catherines, Ont., forcefully presented this danger. Manufacturing establishments and the fire insurance interests alike were joined of late in furthering the installation of private fire protection systems, auxiliary to the regular water-supply. Oftentimes the special supplies are from grossly polluted sources. Specifications for these special systems are generally drawn by the underwriters, but the actual supplies are usually furnished and put in place by private contractors. One or more check valves are generally called for, under the assumption that such valves will be absolutely tight on delivery and after use. Mr. Milne was of the opinion that check valves cannot be relied on for tightness, and cited instances in support of his view. The possibility of the best of check valves getting out of order constitutes a danger of water contamination which should be avoided wherever possible. Where such valves are used, frequent inspections for leakage should be made. Mr. Milne's practice is to insert a service cock between the check and post indicator valves.

Mr. Robert J. Thomas, of Lowell, and Col. H. N. Ruttan, of Winnipeg, both cited instances of typhoid outbreaks due to the kind of interconnections under discussion. Mr. E. J. Peck, of Hartford, Conn., said the Pratt & Cady Co., of that city, had recently designed a double check valve. Installations of these are inspected for leaks at frequent intervals by a young engineer. Small leaks have been found once or twice only.

WATER SOFTENING AT McKEESPORT, PA., AND WINNIPEG, MAN.—A paper dealing with certain phases of the water-softening plant put in operation at McKeesport late in 1908 was sent by Mr. Alex. Potter, of New York City. The water at McKeesport has jumped from a hardness of 110 at 4 a. m. to 510 by 8 or 9 a. m., and in the same period the acidity has risen from 30 to 210. The acidity is due to mine water discharged into the tributaries of the Youghiogheny River, and to waste acids from galvanizing works. While local conditions render comparisons useless unless great care is observed it may be noted, the author states, that the McKeesport plant costs about $10,000 per year for interest and $30,700 for operation, making $40,700 per year for treating an average of 4,000,000 gals. per day. This is more than balanced by the following annual saving: $15,000 per year on repaving at curb connections; $35,000 per year to consumers on plumbing repairs; $6,090 in coal on account of reduced water consumption; $3,000 in plant repairs; $10,000 in soap and soap compounds; $20,000 per year on fabrics laundried. This makes a total of $89,090 saved against $40,700 spent.

The number of plumbers in McKeesport fell from 156 to 46 within four months of the time the plant was put into commission and has continued at about the lower figure since.

Softening at McKeesport is accompanied by filtration. The filters failing to produce any reduction of the bacteria in the settled water, Mr. Potter suggested the use of hypochlorite of lime. This was begun in October, 1909, and has continued since. The result has been an almost sterile water, and the use of a coagulant has been discontinued. From 2½ to 12 lbs. of hypochlorite per 1,000,000 gals. has been used, and the average has been about 4 lbs. The hypochlorite is admitted to the water about an hour in advance of the soda.

A question from Mr. A. Folwell, of New York, gave rise to some interesting information from Col. H. N. Ruttan regarding the softening plant at Winnipeg. When the plant was first installed there were deposits in the pipes. It was concluded that there was not sufficient time for the action of the lime. Aeration and a current of CO_2 were provided and all the lime was then taken up. The plant was run some eight years without trouble. It was discontinued when the consumption increased to double the designed capacity of the plant, or from 2,500,000 to 5,000,000 imp. gals. Doubtless it will be enlarged and reopened some day. It cost the consumer $3 per year and saved him ten times that amount. The water treated is from wells and has a hardness of 400 parts per 1,000,000; of this, 68%, permanent hardness was removed.

WATER-WORKS ADVERTISING.—An advertising campaign to secure consumers and to correct popular misconceptions was conducted in 1909 by Mr. Dow R. 'Gwinn, President of the Terre Haute Water-Works Co. It appears that a large percentage of the people of Terre Haute were still using private wells and without plumbing fixtures until recently. Mr. Gwinn's paper contained copies of a large number of advertisements carried in the three local papers.

OPERATION OF THE SETTLING BASINS, RICHMOND, VA.—Mr. E. E. Davis, of Richmond, presented the final paper. The basins in question were first operated on Dec. 22, 1909, as plain settling basins. Since early in January, 1910, alum has been used as a coagulant. For the month of March the bacteria were reduced by 78%. Using the presumptive test for B. coli, positive results were obtained from raw water and negative results in 0.1 c.c. of the water after coagulation and sedimentation. In larger samples of the filtered water B. coli were sometimes found, but the positive results were few as compared with the river water. The cost of operating the basins averaged $1.44 per 1,000,000 gals. in March.

OTHER PAPERS.—A few other papers were on the program or came in during the convention and were read by title, including: "Suggestions as to Water-Works Fire Efficiency," by W. H. Glore; "Experience with Cement Mains at Rahway, N. J.," by Mr. Bishop; and "Removal of Iron in Organic Combination."

Committee Reports and Other General Business.

ELECTROLYSIS.—Mr. Dabney H. Maury, chairman, reported that on June 1, 1909, a new report was filed in the Peoria electrolysis suit. The master to whom the case had been re-referred for taking new testimony held that there had been no change in the conditions affecting electrolysis since the first hearing [the case opened some twelve years ago.—Ed.] There was no known method by which the complainant [the Peoria Water Co.] could keep the trolley current off its water mains. It is reported that the case will be reargued soon. Several members expressed themselves as of the opinion that many trolley companies, if rightly approached, willingly settle electrolysis damage claims, but

Mr. Maury said that this applies chiefly to minor claims, and that when the damages claimed are large the street-railway companies force law suits. Mr. John Caulfield said that an electrolysis suit compromise was effected at St. Paul some years ago, but the trolley company had failed to follow the recommendation of the engineer engaged by the city, and a new suit had been brought.

DEPRECIATION.—Mr. John W. Alvord, chairman, presented an interesting progress report. The committee has collected hundreds of cards giving specific information on the depreciation of the various parts of water-works plants. Most of the cards show short lives of structures, those reporting not seeming to understand that reports on long-lived structures are also desired. The Knoxville water-rate case, Mr. Alvord said, showed the importance of including depreciation allowances in water-company charges for water. He also thought such allowances were important in the case of municipally-owned plants. The author divided depreciation charges into (1) physical; (2) functional and (3) contingent. The straight-line rather than the sinking-fund method of determining depreciation charges was recommended as the simpler of the two.

UNIFORM ACCOUNTS AND REPORTS.—Mr. Albert H. Wehr, chairman, presented a printed report which made a good-sized book. It included a complete system of accounts, intended to cover all possible conditions, and was accompanied by equally complete explanatory matter. In general, the scheme is in accord with that of the U. S. Bureau of the Census. Mr. Wehr and the incoming president were authorized to attend a conference on this subject called by the Census Bureau for May 24 and 25.

FINANCE.—Through Mr. H. A. Keeler, Chairman, the committee reported a deficit of nearly $3,500. It was recommended that an assessment of $5 per member be levied, leaving it optional with those who made special subscriptions last year whether or not they pay the assessment. It was also recommended that printing papers in advance and supplying authors free copies of their papers be discontinued, and that the publication committee be given discretionary authority in cutting down both papers and discussions. These recommendations were endorsed by the executive committee and adopted by the convention.

REORGANIZATION.—In view of the deficit just mentioned this committee advised that no present action be taken on permanent headquarters and allied schemes for expansion proposed a year ago. Mr. Dabney H. Maury, of Peoria, is chairman of this committee.

SECRETARY-TREASURER.—Mr. John M. Diven reported a present membership of about 950, including members elected up to the second day of the convention. This was a net gain of about 50 members during the year.

OTHER COMMITTEES.—Progress reports were made by the committees on Fire Protection and on Water-Works Standards (Chas. A. Hague, Chairman). A new committee was created to further the movement for a national bureau or department of health, the committee to urge that the proposed bureau be given reasonable control of the pollution of interstate streams; and the committee to have power to cooperate with similar committees from other organizations. Messrs. Theo. A. Leisen, Louisville, Ky., M. N. Baker, New York City, and M. R. Sherrerd, Newark, N. J., were appointed as members of the committee.

ELECTION OF OFFICERS.—Mr. John W. Alvord, of Chicago, was advanced from the first vice-presidency to be president, the four other vice-presidents were moved up a notch, and Mr. Geo. G. Earle, of New Orleans, was enthusiastically chosen as fifth vice-president. Mr. John M. Diven was reelected as Secretary and Treasurer.

NEXT MEETING PLACE.—By a vote of 86 to 80 (some scattering besides) Rochester, N. Y., won as against Richmond, Va. Many remarked that the perfervid and extended pleas of a representative of a Richmond commercial organization lost that city many votes.

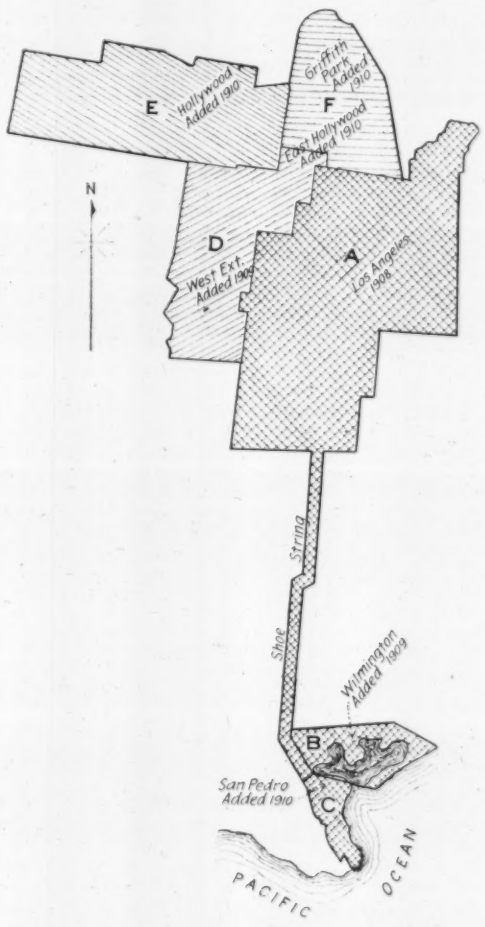
MISCELLANEOUS.—There were interesting excursions to the city water-purification plant, etc., and no end of good entertainment of various sorts. Interesting exhibits of water-works appliances were held under the auspices of the Water-Works Manufacturers' Association, which also looked after the entertainment of members and guests.

An Odd-Shaped City Made Still Odder: Los Angeles, Cal.

By L. R. W. ALLISON.*

In Engineering News of Sept. 23, 1909, page 320, the odd shape of Los Angeles was commented upon. Three annexations since that date have made its outline of even more peculiar shape, as shown in the accompanying sketch map, which proportions the municipality as it is to-day.

Sections "A," "B" and "C" are those to which the above issue of Engineering News called attention, Los Angeles, Wilmington and San Pedro, respectively. Portion "D," known as the "Colegrove-Arlington" Extension, became part of the city late in 1909, by an election ratio of 214 to 5. Section "E," taken into the mother city on Jan. 24, 1910, by a vote of 20 to 1, was formerly the incorporated city of Hollywood, a suburb of 2,500 acres. It brings to Los Angeles a population of 5,000 and a property assessment of many millions. On Feb. 4, 1910, a third election brought portion "F" into the greater city; this section was previously known as East Hollywood, Ivanhoe, Tropico and Griffith Park, this latter (Griffith Park) gives to Los Angeles a park of 3,015 acres—the largest municipal park in the world.



The Latest Addition to the Odd Shape of Los Angeles, Cal.

The territory now covered by Los Angeles is over 100 sq. mi., with an assessed valuation in the hundreds of millions. The Port of Los Angeles (San Pedro) is to be on the line of the new Mexican Pacific Railway, which will extend for 900 miles along the west coast of Mexico, the richest territory on the American continent. As noted by the custom records made public in February, this port is the greatest lumber-receiving station in the world, with receipts for the year 1909 of $511,084,000; including poles and ties, if figured in B. M., it would total over 600,000,000 ft.

[After the publication of our first article on this subject a subscriber called our attention to an ancient and classic parallel to the odd shape of Los Angeles, due to the same general reason as we then mentioned, the desire to make an inland city a seaport by annexation. The city was Athens and the annexed territory was the Piraeus.—Ed.]

*1353 West 30th St., Los Angeles, Cal.

A Proposed Study of Earthquake Causes in California.

A committee, on Rift Belt Deformation, of the Seismological Society of America, at a meeting of the society held in San Francisco on March 2 presented a report which stated that earth stresses like those causing the 1906 earth shock at California still exist and may profitably be studied. From this report as printed in the "Mining and Scientific Press" of April 23, the following is reprinted:

The most important fact brought to light by the investigation of the California earthquake of April 18, 1906, is that a condition of stress existed in the earth's crust antecedent to the rupture which produced the shock. This stress seems to have been effective as a slow tortional creep of the coastal portion of the middle Coast Ranges toward the northwest. It was relieved by a fault rupture along the San Andreas rift at the time of the earthquake, the fault-trace being certainly 190 and probably 270 miles in length. The relief was effected by a forward or northwesterly movement of the portion of the earth's crust lying to the southwest of the fault and a resilience or backward movement to the southeast of the portion lying to the northeast of the fault, the maximum horizontal relative displacement being 21 ft. The fact that similar displacements have repeatedly occurred along the San Andreas rift in time past is warrant for the belief that the stress operative in the earth's crust up to April 18, 1906, was only temporarily relieved by the fault of that date, that the stress is a secular condition of the region, and that the creep of the earth's crust which it induced will be renewed and will accumulate until it is again relieved at some future time by a rupture similar to that which occurred in 1906.

In view of this conclusion it is a matter of the utmost importance to geological science that the phenomena of creep should be most carefully studied. Such a study will doubtless extend through decades and generations, owing to the slowness of the movement, and we can scarcely hope in our time to fully understand it. We may, however, attack the problem in the hope and reasonable expectation of arriving at results which will be of service to humanity. The first step toward this end is the determination of the distribution of the stress as manifested by the slow creep of the region and the measurement of its amount. This, in the opinion of the committee, may be best accomplished by establishing series of monuments extending out in a direction approximately normal to the San Andreas rift at suitable localities and determining their relative positions by careful survey from time to time. Each line of monuments should extend out where possible for at least 20 miles on either side of the rift and be composed of stable concrete piers spaced not more than two miles apart. In the opinion of the committee there should be at least three lines of monuments, one to be placed near the head of Tomals bay, one near the south end of the Bay of San Francisco, and one crossing the rift where it traverses the south side of the Mojave desert. The cost of installing these monuments and establishing their position in the first instance would be about $5,000. The committee recommends that the Society make an effort to secure the money necessary for this purpose.

At the San Francisco meeting of the Seismological Society, above mentioned, resolutions were adopted favoring the establishment of a National Seismological Bureau with power to collect data, to establish observing stations, to investigate special regions of the country (such as the south Atlantic coastal, Mississippi Valley and Pacific coastal regions) and to cooperate with other organizations and individuals.

The Decision of the U. S. Supreme Court in the Oberlin M. Carter Case.

On April 18 the U. S. Supreme Court rendered final decision in the suit against Oberlin M. Carter, formerly a Captain of Engineers, to recover a portion of the moneys received by him through collusion with Gaynor and Greene, contractors for river and harbor work in the Savannah district under Carter as Engineer. This finally concludes the litigation which began with the court-martial of Carter in 1897-8. The course of this long litigation has been followed with so much interest by engineers that we reprint below the most important portions of the Supreme Court decision:

This is a bill which seeks to compel the defendant, Oberlin M. Carter, late a captain in the army of the United States, to account for illicit gains, gratuities and profits received by him through collusion with contractors for river and harbor improvements in the Savannah, Georgia, improvement district.

In substance, the bill charges that under an appropriation made by Congress for the improvement of the harbor of Savannah certain contracts were entered into with John F. Gaynor and Benjamin D. Greene, doing business either in their joint names, or the name of one of them, or as the Atlantic Contracting Co.

It is charged that Carter entered into a corrupt arrangement with the said contractors, by which he undertook to use his power and discretion in the preparation of specifications and contracts, and in advertising and letting the same out in such a way as to enable Gaynor and Greene to become contractors under conditions which would insure them a large profit, and to use his influence, power and discretion in the supervision and acceptance of the work to their greatest advantage. It is then, in substance, averred that in consideration of such service to them and the betrayal of his trust he should share in the profits and receive one-third of every distribution made. It is charged in substance that under such agreement or understanding there was paid over to the defendant Carter about $500,000 as his share of the profits, and that the same was converted into real estate, bonds, stocks and negotiable notes, and that much of these gains were later placed in the custody of certain other defendants named in the bill, two of them being brothers of defendant Carter, to wit, Lorenzo D. Carter and I. Stanton Carter, who are charged as holding same as agents for Oberlin M. Carter. Securities aggregating in value some $100,000, into which the larger part of the share of the defendant Oberlin M. Carter is said to have gone, were attached under this and other bills, ancillary in character, and placed in the hands of a receiver to abide the result of a decree in this case.

There was a decree in favor of the United States in the Circuit Court substantially as prayed for. Upon an appeal by the defendants and cross-appeal by the United States to the Circuit Court of Appeals, the decree was affirmed as far as it went, and was enlarged in certain matters upon the appeal of the United States. The original defendants have appealed from this last decree so far as it was favorable to the complainant, and the United States has perfected a cross-appeal with reference to certain parts of the decree with which it is discontent. Thus the whole case is here as upon a broad appeal and the several appeals have been heard upon the entire record, consisting of some thirty printed volumes.

The facts essential to be stated, as sifted out of this great record of pleadings and evidence, are these: From some time in 1889 until July 20, 1897, Oberlin M. Carter, then a brilliant and rising officer of engineers in the army of the United States, was assigned to duty and placed in charge of certain improvements, for which an appropriation had been made, in the harbor of Savannah. It is undoubtedly true that the plans, the form of contracts, the character and time of advertising, and acceptance of bids, as well as most matters involving the exercise of judgment and discretion during the execution of contracts, were reported to the War Department for its approval or rejection. Nevertheless it is most thoroughly made out that the action and recommendation of a local engineer officer in charge of such work practically determined the situation so long as he had the confidence of his superiors and kept within the general limits of the appropriation by Congress for the work in hand.

Aside from certain contracts prior to September, 1892, and subsequent to May, 1896, the Circuit Court found, and the Circuit Court of Appeals confirmed the finding, that between September 16, 1892, and May 12, 1896, the United States, through the defendant Oberlin M. Carter, as its disbursing officer, paid to Gaynor and Greene, or the Atlantic Contracting Co., a corporation of which they owned all of the shares except a few assigned to certain kinsmen for organization purposes, on account of what we shall hereafter describe as Gaynor and Greene contracts, the sum of $2,567,493.48. They also found that of this sum $1,815,941.62 was distributed as net profits between John F. Gaynor, Benjamin D. Greene and some third person not publicly known to be interested. The remainder, $751,551.86, was the sum disbursed by Greene and Gaynor for labor, supplies and salaries, being the actual cost of the work for which the Government had in some way been induced to pay, under contracts drawn and supervised by Captain Carter, the sum of $2,567,493.48.

These figures are not derived from any set of books kept by either the contractors or by Carter. Though the execution of these contracts extended over a period of four years and involved the receipt and expenditure of millions, yet the contractors say they kept no books other than one which related to supplies bought and ordinary labor or salary accounts, and that that book could not be produced.

The plan under which Greene and Gaynor carried on these great affairs, as shown by the evidence, was to apply monthly payments received from Carter, as the Government's disbursing officer, to the payment of the monthly expenses and advances which might have been made by one or the other of the contractors, and then divide the balance into three parts, one part being at once handed over to Greene, another to Gaynor and the third to some third person, who both courts found upon the evidence to have been one Robert F. Westcott, the father-in-law of the defendant, Oberlin M. Carter, or to accounts kept in his name, and that this third was ultimately turned over to Carter himself.

Without any distinct finding as to the method by which the Government had been defrauded or as to the extent of actual loss sustained, both courts concurred in the conclusion that the Government had been defrauded, and had suffered great loss. Without any distinct finding as to whether one-third of the profits realized had been paid over to Robert F. Westcott as a secret partner with Greene and Gaynor, or to him as the representative of Captain Carter, yet both courts concurred in holding that, if Westcott was interested as a partner in the contracts, Carter, under all of the facts, was chargeable with knowledge of such partnership relation, and that, if with such knowledge he accepted from Westcott the share of profit so received, he was accountable to the Government for all such illicit gratuities or gains. In view of this concurrence of opinion upon these material facts the burden rests heavily upon the appellant Oberlin M. Carter to satisfy this court that their conclusions are plainly erroneous, or that, conceding the facts to be as found, the decree holding him accountable is erroneous as matter of law.

But counsel have urged with great force and much confidence that the conclusion of both of the courts below rests upon no secure foundation, and that there has been a great miscarriage of justice in finding that Captain Carter was ever in any way interested in these contracts or that he ever, directly or indirectly, consciously shared in any profits arising therefrom. This protest does not, as we understand it, involve any serious denial of the fact that nearly two millions of dollars were realized as profit upon contracts drawn by, let out and supervised by Captain Carter at a net cost to the contractors of less than one million dollars; nor does it involve any serious denial that approximately one-third of this abnormal profit was paid over to some third person not publicly known to have had any connection with the contracts or the contractors. If, however, we are in error in assuming such a limitation upon the contention of counsel, there is no reasonable ground, upon this record, for doubting the correctness of the conclusion reached by the courts below as to either of these matters. It may be conceded that no witness proves an express agreement between the contractors and Carter that he should serve them in the letting or execution of these contracts. So far as the principals have spoken, they have denied any such agreement.

But it is said that none of the specific averments of the bill as to the methods by which the Government had been defrauded were sustained by either the Circuit Court or the Circuit Court of Appeals. Thus it was averred that Carter had shortened the time required by regulations for advertising for bids, that he had made it difficult for some intending bidders to secure the plans and specifications, that he had deterred others by unduly magnifying the risks of the work, that the specifications were so drawn as to leave to the Government the option of two or more materials of different value, or two or more methods of doing parts of the work, or the right to substitute one material for another. It was also averred that Greene and Gaynor were in advance advised as to how such options would be exercised, but that other proposing bidders were not, and that by this and other artifices Greene and Gaynor were enabled to secure contracts at unreasonable prices. It is then averred that Carter had collusively and fraudulently increased unduly the quantity of some materials required and diminished that of other kinds; that he had exercised options reserved in such a way as to greatly increase the cost of the work and the profit of the contractors; that he had permitted changes in materials and methods of using the materials and of doing the work in such manner as to be of disadvantage to the United States and of advantage to the contractors, and that he had permitted the use of cheap and inferior materials and had accepted bad and inferior work.

Aside from the elusiveness of a fraud well concocted and unsuspected while going on, there was in the way of the Government in this case the fact that in respect to almost everything which had served to add to the cost of the work and to the profit of the contractors Carter had confessedly a wide discretion. That he might be controlled in the exercise of this by his superior officers or by the War Department when important changes, modifications or substitutions were made, is true. But, in actual practice, this War Department approval was largely official and formal when the engineer in charge was regarded as capable and honest and his recommendation within the limit of the appropriation or of the contract as made.

It was the fact that such an officer in control of such work had a wide discretion which at once made his fidelity of the utmost importance to the Government and his cooperation and collusion of such large value to the contractors. This discretion was the stumbling block in the way of the Circuit Court. It was not easy to show in some instances that the work had suffered by the substitution of one material for another, or by the increase of one kind of mat in mattress work for another, or by one method of measuring or paying for mattress work rather than by another. When contracts and specifications were elastic enough, as seems to have been the case with Greene and Gaynor contracts, to justify varying interpretations, or full of options as to materials or methods, as was the fact here, nothing short of conduct or action plainly indefensible as an exercise of honest judgment would justify an inference of corruption. When to this situation there was added the fact that as a whole the harbor improvement had been intelligently and scientifically carried out and was apparently an engineering success, and that this result had been reached within the limit of the Congressional appropriation, it was not surprising that upon this line of evidence, considered apart from all other things, the Circuit Judge found himself unable to predicate fraud and corruption upon the conduct of Carter in these details which the bill pointed out as the methods by which he had enabled a great fraud upon the Government to be carried out and by which his corrupt collusion was to be established.

But the case of the United States against the defendants is not to be determined by the consideration of the sufficiency of any one fact or group of facts, but by a judgment based upon the evidence as a whole. The learned Circuit Judge very nearly fell into error by such a partial view of the case. From ultimate error he was saved by the subsequent consideration of the principal, and really determinative, factors in the case, namely, the abnormal profit which the contractors had in some way been able to realize, and the evidence tracing one-third of that profit into Carter's hands, with no credible reason for such result. The Circuit Court of Appeals took a somewhat wider view of the matter. Thus that court said:

"Under the settled facts above recited, linked with cumulative evidence, tending to prove actual knowledge on the part of Captain Carter of the excessive profit in the mattress work and of divisions thereof with Westcott in New York, and complicity in the fraudulent transactions, of which (at one time or another) he acquired approximately one-third of the net proceeds, we are constrained to the belief that the evidence is decisive, not only of frauds perpetrated by the contractors, but of concurrence and participation therein by Captain Carter."

If it be once assumed that the defendant Carter did secretly receive from Greene and Gaynor a proportion of the profits gained by them in the execution of the contracts in question, the right of the United States in equity to a decree against him for the share so received is made out. It is immaterial if that appears whether the complainant was able to show any specific abuse of discretion, or whether it was able to show that it had suffered any actual loss by fraud or otherwise.

It is not enough for one occupying a confidential relation to another, who is shown to have secretly received a benefit from the opposite party, to say, "you cannot show any fraud, or you cannot show that you have sustained any loss by my conduct." Such an agent has the power to conceal his fraud and hide the injury done his principal. It would be a dangerous precedent to lay down as law that unless some affirmative fraud or loss can be shown, the agent may hold on to any secret benefit he may be able to make out of his agency. The larger interests of public justice will not tolerate, under any circumstances, that a public official shall retain any profit or advantage which he may realize through the acquirement of an interest in conflict with his fidelity as an agent. If he takes any gift, gratuity or benefit in violation of his duty, or acquires any interest adverse to his principal without a full disclosure, it is a betrayal of his trust and a breach of confidence, and he must account to his principal for all he has received.

Reading the evidence in relation to Captain Carter's conduct in drafting the specifications, advertising, acceptance of bids, and more particularly his almost invariable exercise of options and other discretionary pow-

ers in the subsequent execution of the contracts let to Greene and Gaynor, in the light of the abnormal profit realized by them, of which, approximately five hundred thousand dollars ultimately found its way into his possession, we can but entertain a strong conviction that his relations with them from the beginning were inconsistent with his fidelity to the United States, and that he must account to his principal for every dollar of gain or profit or advantage which has been derived by him from these contracts.

The defense against such a conclusion rests upon three propositions:

1. That the affirmative evidence that he abused his discretion and secretly and corruptly favored Greene and Gaynor is not sufficient.

We shall not consider this proposition apart from the other two, for it is not material whether the evidence referred to, considered out of relation to the other parts of the case, would or would not make out a case of fraud.

2. That, in view of the great risk attendant upon such works, the profit claimed to have resulted was not so abnormal as to justify an inference of fraud, and that it was in part due to cheap labor, bordering upon peonage.

Neither should this contention be considered apart from the chain of evidence, which leads to but one inevitable result, namely, that this great profit was not legitimate. Looked at, apart from everything else, a profit of $1,815,941 upon a job which cost the contractor but $751,551 arouses deep suspicion, and demands a clear explanation. That explanation does not appear in the facts of this record.

3. It is urged that Captain Carter's greatly increased personal expenditures during the progress of this work, and his acquisition of some four hundred thousand dollars' worth of bonds, stock and other property, much of which has been impounded in this case as property into which his illicit gains and gratuities have been traced, arose from the generous bounty of Robert F. Westcott, and that Carter was ignorant of any interest Westcott had in the Greene and Gaynor contracts, and of the fact, if it be a fact, that Westcott's gratuities came from his participation in the distribution of the profit on the Greene and Gaynor contracts.

This last proposition presents the very crux of the case. What was Westcott's relation to the Greene and Gaynor contracts? It has been suggested rather than urged that he was, secretly, a partner in these enterprises. There is no evidence that he was, other than the fact that very many profit dividends are traced to bank accounts standing in his name. But, if he was, and Carter bargained with him for a share in the profit, knowing his relation, the legal consequence is the same as if he had received the same interest from Greene or Gaynor.

But the apparent participation of Mr. Westcott in the profit arising from the Greene and Gaynor contracts is not inconsistent with a mere agency for Carter, and such an agent we think he was. That Carter could not openly receive any gains or gratuities from Greene and Gaynor is obvious. Some go-between was essential. The requisite conditions for such a screen would suggest Mr. Westcott. He was an aged retired business man of some fortune, residing in New York. Captain Carter, in October, 1890, married one of his daughters. Mrs. Carter died in December, 1892, leaving no issue. During the marriage Mr. Westcott made Mrs. Carter a small monthly allowance. His regard and esteem for Captain Carter, during the time of and subsequent to this marriage was, on the evidence, very pronounced, and this relation affords the basis for the claim that Captain Carter's greatly increased personal expenditures during the progress of the Greene and Gaynor contracts was due to Mr. Westcott's generous and unceasing gratuities.

It is shown that Captain Carter's income was substantially limited to his pay as captain and that his personal expenditures did not exceed three or four thousand dollars per annum down to 1892. From then on his expenditures steadily increased, until they reached and passed twenty thousand dollars per annum. Now it cannot escape observation that this great change in his manner of living began with the Greene and Gaynor contracts and became more and more marked through the progress of the work under his supervision. It does not follow, of course, that the means for such widening expenditures came from these contracts, but the circumstance is suspicious and calls for satisfactory explanation.

Among other details averred in the bill of complaint is, that, beginning in 1892 and continuing down to 1896, Captain Carter was continuously engaged in making investments, in loans, real estate, bonds and stocks, and that the amount so invested aggregated more than four hundred thousand dollars. Many of these investments turned out to be in the identical securities, which, after much difficulty, were impounded under the process in this case, and are now in the hands of the receiver.

That the increase from these investments was collected by him, ostensibly for Mr. Westcott, is not questioned. That he applied it to his own personal use is shown by a comparison of the bank accounts standing in his name and those in the name of Westcott, as well as by the inference to be drawn from the remarkable correspondence between the increasing volume of this income and his own personal expenditures. Now Carter does not deny that he did make large investments during 1892, and the years following, nor that the properties and other securities impounded in this case are in large part the result of such investments. What he does claim is that in making such investments he was acting for Wetscott under powers of attorney which cover most of the time, and under oral authority during the rest. His use of the income from such investments or of means approximating such income, he says, was due to the generous bounty of Mr. Westcott. His title and right to the property in which he made such investments for Mr. Westcott he distinctly sets up in his sworn answer as resting alone upon donations made to him in October, 1897, and he sets out as evidence of title two receipts. In that he says that he "never had any interest, direct or indirect, in the securities described in the receipts of October 11 and 29, 1897, until the same were respectively given to this defendant as a pure and original donation by said Westcott at the time of said respective receipts in October, 1897."

The first of these receipts reads thus: "Received New York Oct. 11, 1897, from R. F. Westcott the following bonds, sixty-three in all." Then follows the numbers and description of bonds. Signed "O. M. Carter." The other reads thus: "Received New York Oct. 29, 1897, from R. F. Westcott, the following instruments." Then follows a long list of notes, mortgages, stocks and bonds. Signed "O. M. Carter." The securities described in these receipts are undoubtedly the same securities bought by him from time to time, ostensibly for Mr. Westcott. These purchases and investments show a remarkable correspondence in date and amounts with the dividend distributions of Greene and Gaynor profits, and undoubtedly represent the one-third of such profit nominally paid to the account or credit of Westcott.

During the years covering these distributions Captain Carter, according to his own account of matters, stood for and represented Mr. Westcott, sometimes by oral direction and sometimes by power of attorney. Certain it is that there was a blending of the business affairs of the two men rarely ever seen. Under Carter's powers of attorney he checked upon Westcott's bank account as his own. He had free access to his safe deposit box, where these securities were kept, and collected interest and dividends as they accrued. Certain investments of large amounts were shown to have been made by him which did not appear in Westcott's bank account. This was explained by Carter, who, in substance, said that Mr. Westcott had, on going off to Europe, left a large amount of currency in his safe deposit box, and that he invested this money for Westcott. Not less than one hundred thousand dollars of money appears to have come from that source, and yet Carter says that he cannot say how much Mr. Westcott left there, nor how much remained when he returned, and that although he and Mr. Westcott had occasional settlements, they neither gave nor received receipts nor rendered accounts.

There is no positive, competent evidence explaining just why these securities were in the personal custody of Mr. Westcott in October, 1897. Captain Carter was relieved at Savannah in July, 1897, by Captain Gillette, who very early discovered indications of maladministration by his predecessor. By direction of General Wilson he pressed his investigations and caused charges to be preferred. In August, 1897, and before Gillette's discoveries had been made public, Captain Carter was sent to England as military attache with the American embassy. Within a month he returned, doubtless due to orders, only to find that serious charges, involving his career and his honor, had been preferred, and that his management of the Savannah district improvements was about to undergo a thorough investigation. There is evidence, as we have before stated, strongly tending to show that he had himself collected the interest and dividends upon the shares and bonds mentioned in these receipts up to the time he went abroad, a fact which points to his having had personal custody of these securities up to that time. Though there is no competent positive evidence that he did turn these securities over to Westcott, or caused them to be placed in his hands, for safekeeping, before his trip abroad, there is good reason for believing so.

Frederick P. Solley, another son-in-law of R. F. Westcott, says that he went with Mr. Westcott to his safe deposit box in October, 1897, to get these securities. The statement then made to him by Westcott as to why he had possession of these instruments was objected to as not competent, being declarations in the absence of Carter. The objection was sustained, and there is no error assigned. Solley says "that he and Westcott carried them to the office of Mr. Stimson, Westcott's lawyer;" there a list was made out and the witness checked them over. He did not see them delivered to Carter. But Mr. Stimson did. What explanation Mr. Westcott made to him of the transaction before Carter's arrival and delivery to him has been excluded, because not made in Carter's presence. He, however, saw the transfer, and saw the receipt signed. The significance of Stimson's evidence as to what was said in the presence of both Westcott and Carter is that nothing was said as to this being a gift, and that no acknowledgment was made so indicating. He does not recall anything said by Westcott in the presence of Carter. He does, however, say that after Carter had taken the securities, alluding to a number of bonds which were among the securities, he said: "Daddy, I want you to take these," or "Daddy, I want to give these bonds to you. Something substantially to that effect, and that Mr. Westcott replied: 'No,' either verbally or with some gesture of dissent. Captain Carter put the bonds which he had referred to back with the others and took them all." A proposal to give to Westcott a part of the very securities which Westcott was then giving to Carter as a "pure donation," is incompatible with the latter contention; it accords more with the attitude of one who was receiving back his own from one who had performed a great service as custodian of property which the owner had reason for concealing from publicity.

A more significant fact pointing to the same conclusion is that Robert F. Westcott did not come forward and testify in favor of his son-in-law before the board of inquiry, or before the subsequent court-martial. The investigation before the board of inquiry and the trial before the court-martial involved Carter's execution of the contracts in question, and his business relations with both the contractors and with Westcott. In both investigations Carter claimed, then as now, that his large personal expenditures were met by gifts to his wife and, after her death, to himself by Mr. Westcott, and that in the purchase of large amounts of securities and other property he had only acted for Mr. Westcott. The testimony of Mr. Westcott was vital to his defense upon the merits. The board of inquiry sat in the fall of 1897, and the court-martial later. Westcott was living during both proceedings; but he appeared in neither, though urged to appear by General Gillespie, the president of the board. When the evidence was taken in the pending case he was dead, having died in July, 1901.

After Carter had been convicted there occurred in the city of New York certain removal proceedings before a United States commissioner, for the purpose of removing Greene and Gaynor from New York to Savannah for trial upon indictments there pending for the very fraud here under consideration. Carter was included in the same indictments, but was not a party to the removal proceedings mentioned. In that case Mr. Westcott was examined by the United States. His evidence then delivered was offered by the United States in the Circuit Court as evidence in this case, but was excluded upon objection, as having been given in a proceeding to which Carter was not a party and without opportunity for cross-examination by him. The objection was rightly sustained. The evidence was, however, admitted for the purpose of fixing notice upon the defendants Lorenzo D. Carter and I. Stanton Carter of the character of the title of their brother, Oberlin M. Carter, to the securities involved in this suit. The evidence was properly admitted solely for the purpose of showing Westcott's disclaimer of any title to or interest in the securities which he handed over to Carter, as shown by his receipts mentioned above. We, however, exclude any statement made by him as against the defendant Oberlin M. Carter.

The conclusion we must reach is, that Robert F. Westcott was but the agent and representative of Oberlin M. Carter in the receipt of a share in the profit made by Greene and Gaynor.

For whatever gains, profits or gratuities he is shown to have received he must account.

The contention that any recovery must be limited to property or security into which such illicit gains have been traced is not sound.

FOURTEEN 1,200-VOLT direct-current systems for railway lines have been adopted, according to the recently issued annual report of the General Electric Co., of Schenectady, N. Y. Two of these are in Italy and twelve are scattered about this country. It is stated that over 66,000 HP. of 1,200-volt motors had been built or ordered up to Dec. 31, 1909.

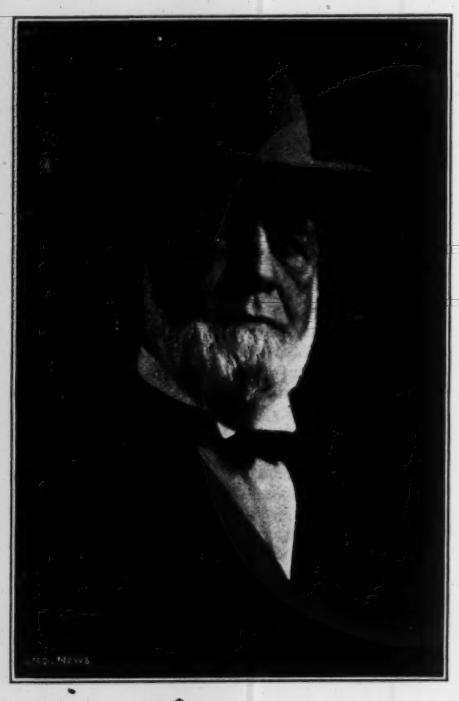
INVENTION OF MERCURY RECTIFIER.—A long patent litigation was recently ended by a decision of the Court of Appeals of the District of Columbia, which awarded to Peter Cooper Hewitt, of New York City, priority of invention for the use of mercury-vapor vacuum tubes in changing alternating currents of electricity to uni-directional. The interfering claim was filed by Mr. E. Weintraub, of the General Electric Co., Schenectady, N. Y., Oct. 18, 1902. If the current through one electrode of the Cooper Hewitt rectifier should fail the device would be inoperative until restarted. In the Weintraub form, if the alternating current should fail, the device remains operative until the current is restored. This difference, it was decided, has no effect on the basic claim of Mr. Hewitt and Mr. Weintraub is entitled to claim specific improvement only.

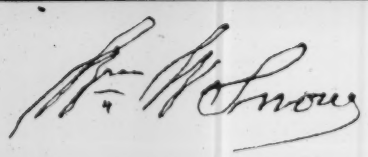
William W. Snow.

William Wait Snow, whose death occurred at his home in Hillburn, N. Y., April 26, has long been prominent in this country as a manufacturer of railway supplies. Since early in the '50's, up to the time of his retirement in May, 1909, he had been active in the management of the industries established under his direction in the Ramapo valley.

Mr. Snow was born at Heath, Mass., July 17, 1828, and was educated in the schools of that village. His earliest employment was as a bookbinder. Having learned this trade, he worked at it for a time at Troy, N. Y., but after only two or three years of this work, his energy was diverted into the channels in which he subsequently became so successful.

His first work as a foundryman was in his brother's establishment at Woonsocket, R. I., and he was later employed as foreman of a foundry in Indianapolis, Ind. Returning to the East in 1856 or '57, he started a car-wheel foundry at Newburgh, N. Y., in partnership with Isaac





Stanton under the firm name of Stanton & Snow. In undertaking this enterprise, Mr. Snow acted upon the advice of Homer Ramsdell, who was at that time President of the Erie R. R. When the firm of Stanton & Snow went under in the panic of 1857, after barely a year of operation, Mr. Snow started in again as a foundryman. He soon obtained a position in charge of the Union Car Wheel Works at Jersey City, N. J., remaining in this place about six years.

The Ramapo Wheel & Foundry Co., the first at the Ramapo valley works, was organized by Mr. Snow at Ramapo, N. Y., in 1866. The Ramapo Iron Works was started in 1881. The Ramapo Foundry Co., organized some time about 1902, was later combined, about 1906, with the American Brake Shoe & Foundry Co. Mr. Snow was practically in control of these and numerous minor concerns.

At the time of his retirement in May, 1902, Mr. Snow entirely relinquished his active interest in all of these companies. He divided his property at this time among his three children, Miss Laura E. Snow, Mrs. Elmer J. Snow and Fred. W. Snow. His son, Fred. Snow, is now President of the Ramapo Iron Works and a director of the American Brake Shoe & Foundry Co. As can be seen in the accompanying photograph, taken in 1906, William Snow, in his old age, was remarkably hearty and vigorous.

A Destructive Fire in a So-Called Fire-Proof Building.

On March 4, 1910, a fire broke out in one of the upper stories of Alwyn Court, one of the most elaborate of New York City's apartment houses and before being extinguished, destroyed many thousand dollars worth of property, mostly in trimmings and furnishings. (Engineering News, March 10, 1910, p. 297.) The fire caused much comment at the time on account of the supposedly fire-resisting construction of the building, so that the following notes on the structure and the fire, taken from the April, 1910, issue of the "Quarterly of the National Fire Protection Association," are of great interest:

CONSTRUCTION.—Twelve-story basement and sub-basement fireproof building of skeleton steel construction. Erected 1909. Area 100 × 115 ft. Flat 4-in. cinder concrete floor arches with a rough floor of ¾-in. boards on wood sleepers, filled in between with cinder concrete and ¾-in. finished parquet floor of oak on top; 12-in., 31½-lb. I-beams, a few beams 10 ins., 25 lbs.; 5 ft. to 6 ft. 11 ins. on centers; 12-in., 15-in. and 18-in. 40, 42 and 55-lb. I-girders; most floors above first have twin 12-in., 40-lb. I-beams for principal girders. Built up steel columns using two channels and two plates, some latticed columns used on ninth floor and above; exterior columns protected by 4-in. brick, others by 2-in. composition plaster blocks with air space between blocks and columns. Girders protected by arches and 3 ins. to 4 ins. of cinder concrete on web, and wire lath and plaster on lower flanges; beams by arches on web and wire lath and plaster on flanges. Foundation base of columns rests on cement on rock. Curtain walls carried on steel frame and range from 20 ins. on first floor to 12 ins. at top; walls of brick, faced with highly ornamental terra cotta north and west, brick south and east. Partitions of 3-in. plaster blocks set in wood framework. Roof of similar construction to floors; roof structure about three-fourths the area of building; sides built of terra-cotta blocks set in steel framework and covered with corrugated iron on the outside. Stairs of iron with steel web plates under marble treads and landings; enclosed in 4-in. terra-cotta shaft, unprotected openings to hallways. The latter formed by partitions of 3-in. composition blocks with "kalamein" doors to apartments. Three elevators separately enclosed in shafts built of 4-in. terra-cotta blocks set in angle iron frame work, with "kalamein" doors at openings to hallways; the doors to elevators and in hallways have mirrors set in the panels over the metal. The west apartments at ninth and tenth floors, in which the fire started, are connected by two open stairways and an open wellhole, forming a duplex apartment. Walls in dining rooms finished in paneled oak; walls of reception halls largely wood with Circassian walnut stain. Sides and ceilings elsewhere mostly plastered, part direct and part on wooden furring; the trim is of wood, painted white.

OCCUPANCY.—Sub-basement was occupied for boiler room, coal and general storage. Basement, laundry and dry rooms, servants' and janitors' quarters. First to 12th floors, two apartments to a floor, 14 rooms and 5 baths each. The 9th and 10th floors at west side constitute a duplex apartment and are connected by two open stairways and an open wellhole. Maids' quarters in roof structure.

CAUSE OF FIRE.—Spontaneous combustion of waste material used by painters is generally accepted as the cause.

PROGRESS OF FIRE.—The fire started on the 9th floor at the west side, in the lower story of the duplex apartment, which was being rearranged and specially finished by the occupant. Many of the rooms contained an unusual amount of lumber in the form of wood trim, parquet flooring, side and ceiling paneling and other decorative woodwork. The painters' supplies were on the 9th floor. There was no furniture in this apartment; the 11th floor apartment was also empty. The fire spread directly through open stairways and wellhole to 10th floor, and was burning throughout the 9th and most of the 10th floors in the duplex apartment when discovered. It was first noticed when the flames burst through the windows, perhaps 20 minutes after the fire started. It spread rapidly from the 10th to 11th floors, and in turn to 12th floor through the exterior windows, particularly in the dining rooms at angle of south wall. These rooms were completely gutted by the fire, due chiefly to the fuel afforded by oak-paneled walls. The tin-clad fire doors at hallways prevented the fire from spreading horizontally. The fire was fought by using the inside standpipes, and by carrying leads of hose up through building. The water tower streams are said to have reached as high as the top floor, but could not be directed into the windows at that height.

DAMAGE TO STRUCTURE.—The 9th and 10th floors in the duplex apartment were gutted except the northerly rooms of the 10th, which are badly damaged. The dining room and reception hall of west apartment on 11th floor were practically gutted, with heavy damage in kitchen and moderate damage in other rooms. In the west apartment on the 12th floor, the dining room, reception hall and living room, including salon, were practically gutted; considerable damage in kitchen and maids' room; only moderate damage in northerly rooms. The west apartments immediately below the floor where the fire started had considerable water on ceilings, walls and floors; part of ceiling plaster has fallen in a few rooms. There was no fire and but little water damage in easterly apartments, including those above the 8th. There seems to be no structural damage to the steel frame or its fireproofing; the lower flanges of the floor beams were protected only by plaster finish, which fell off and exposed the flanges to considerable heat, but no deflection of beams is apparent. The channel shaped steel lintels over dining room windows were softened by the heat and deflected, particularly those on the 12th floor. The 3-in. plaster block partitions are intact except around doorways, where they were supported by wooden framework, which was entirely burned away and caused the blocks to fall. The ornamental glazed tile at west front sustained slight damage to cornice at 10th. A small portion of the hollow metal roof cornice was broken away to ascertain if there was any fire back of it.

RECOMMENDATIONS.—A concerted effort should be made to minimize the amount of wood used in wall finish and for other extensive decorations, particularly in the upper floors of fireproof buildings, where public fire protection is not readily available.

While hard wood is now popular for interior decorations, there are other materials which make acceptable substitutes and their use should be encouraged by architects and builders.

Ordinary glass windows greatly facilitate the vertical spread of fire exteriorly from floor to floor, particularly in the upper stories of fireproof buildings, where the fire department streams cannot readily reach the windows. This fact reduces the efficiency of fire stops for floor openings, and deserves careful consideration from the standpoint of safeguarding life and property in high buildings used for residence or other purposes.

The exterior windows in conjunction with the fuel afforded by the oak paneled side walls in dining rooms caused the fire to spread rapidly from floor to floor until it reached the roof.

Outside fire escapes with landings at each floor should be required by law on all fireproof buildings and be located adjacent to inside or outside standpipes having hose connections convenient to be handled from the landings.

New York, with its abnormally high fireproof buildings and congested values, is seriously deficient with regard to this type of fire protection, in comparison with other cities. These exterior fire escapes are often important in saving lives, and are essential to the fire department if water from the separate fire main system or steamers is to be applied effectively and promptly in the upper stories. Valuable time was lost in this fire owing to the lack of outside fire escapes.

Considerable wood furring was used to carry portions of the wall finish. Wood furring is always objectionable, but particularly so in fireproof buildings, and its use should be avoided.

In this fire the hollow space and wood furring helped to carry the fire, and where it had not been burned the firemen chopped it down, to be sure there was no fire left in the concealed space.

A New Engineering Building for Union College, Schenectady, N. Y.

A new building for the use of the Engineering Department of Union College was opened with appropriate exercises on Thursday, April 28. The funds for the construction of the building were the gift of Mr. Andrew Carnegie. The new building is a very welcome addition to the facilities of Union College, as the Engineering Department has had a rapid growth there, particularly in the Electrical Engineering Department, on account of the facilities offered to students in connection with the General Electric works close by.

The most notable feature of the exercises was the address by Prof. George F. Swain, of Harvard University. Prof. Swain took for his subject "The Limitations of Efficiency in Engineering Education." He gave a careful and critical analysis of the present educational system, with particular reference, of course, to the work of the engineering schools, and clearly set forth the underlying causes for much of the complaints concerning the work of educational institutions that are heard from time to time.

An address was also delivered by Prof. Edward W. Bemis, Deputy Water Commissioner, New

York City, setting forth the need for engineers of broad training, familiar with the principles of sociology and civics, for the positions rapidly opening in various lines of public service. Formal greetings were also presented by Dr. Andrew S. Draper, Commissioner of Education of New York City, President Garfield of Williams College, and Dr. Franklin H. Giddings of Columbia University.

The new building is a massive stone structure of three stories and basement. The first and second stories are given up to recitation rooms, the third floor to drafting-rooms, and the basement affords facilities for a hydraulic laboratory and for cement testing.

Sewage Purification Results at Plainfield, N. J., 1909.

By ANDREW J. GAVETT.*

The sewage disposal works of Plainfield, N. J., consists of four septic tanks of a combined capacity of 1,350,000 gals., eight primary and eight secondary contact beds, having a total net area of 3½ acres. Two tanks and eight beds were constructed in 1900 and the others in 1905.

The sewage from the 44 miles of sewers is almost entirely domestic, there being only a small quantity of trade waste from one factory.

Owing to the dry weather for several years, and consequent diminution of the amount of ground-water infiltration, the flow of sewage did not materially increase during the year, notwithstanding the fact that 236 additional connections were made with the sewers. Of these connections, 112 drain to the sewage lift, and the amount of sewage pumped is about 50,000 gals. per day. The total flow of sewage is now about 1,650,000 gals. per day.

The works have been operated under the direction of Hering & Fuller, Consulting Engineers; Mr. R. S. Lanphear, Chemist, has continued as their representative in immediate charge of the works.

The analyses of the final effluent show that it has continued to be satisfactory without exception, as regards appearance, odors, and the reduction of organic matter and bacteria, and no putrefaction of the effluent occurs in Green Brook after dilution with the stream flow.

The septic tanks have given better service during the past year than previously, as the bacterial functions seem to have become somewhat more advantageously established than hitherto. Ordinarily two tanks are used at a time, each pair in rotation, with the period of service considerably longer than was the case a year ago. Tanks 2 and 4 were in continuous service from Sept. 1, 1909, to the end of the year.

In April, 1909, all four of the septic tanks were cleaned out, the amount of scum and sludge being estimated at 1,600 cu. yds., equivalent to 2.4 cu. yds. per million gallons of sewage treated since the tanks were cleaned in February, 1908. The sludge was drained out onto the lower sand filters and the dried sludge was applied to land cultivated by the Alms Committee.

The septic tanks were cleaned again in March, 1910, and the amount of sludge and scum removed was considerably less than that of the previous year.

The contact beds have had the scum removed from their surfaces at frequent intervals during the past year. The primary beds are considerably clogged and needed cleaning a year ago, but this work was postponed pending a decision on the proposition to join with North Plainfield and construct a plant in another location. To remedy the difficulty temporarily, without going to the expense of removing and washing the entire body of filtering material, several trenches about 4 ft. wide have been made in each of the primary beds, each having three rows of half-round pipe or horse-shoe tile, the ditches being filled with coarse stone around and over the drains to the normal surface level.

With a view to minimizing the odors, the outlet channel conveying the effluent from the septic tanks to the contact beds was covered with concrete, and the pipes distributing the septic effluent to the primary beds were changed so that they fill the beds from the bottom instead of at the surface, as formerly. The secondary beds are still filled at the surface. These changes resulted in a decided reduction of odors.

A tabular summary of the monthly average results of chemical and bacterial analyses of representative samples of sewage and of various effluents is appended.

*City Surveyor and Street Commissioner, Plainfield, N. J.

The Increase of Traffic and of Accidents on the Street Railways of New York City.

That the dangers of travel in the crowded city streets are constantly on the increase is probably a trite and obvious observation, but some comparative figures called forth by a recent excursion into the old files of Engineering News give it statistical confirmation. In the accompanying table is an abstracted record for the years 1886 and 1907-08 of the traffic and fatal accidents on the traction systems of the City of New York. The earlier record is taken from a contemporaneous issue of Engineering News; the later is an abstract of the most recent report of the Public Service Commission for the City of New York. This comparison is very interesting. It shows that while the population of the city has increased in ratio of 2.9 to 1, the street car traffic (including surface, subway and elevated) has increased as 5.1 to 1 and the persons killed on or by the cars, 12.5 to 1.

The table also shows that in spite of the enormous increase in the mileage of the through traffic systems, that is, the subways and elevated lines, since 1886, the passenger traffic on the surface lines has kept an even pace with that on the former, a ratio of increase of 5.1 to 1 holding for both. Most curious of all to us of this age of clanging, hurrying electric cars is the record that 23 persons managed to get killed on the slow moving horse cars in the year 1886.

	Jan.-Dec., 1886.			July, 1907-June, 1908.		
	Surface			El. or		
	Elevated.	Horse cars.	Total.	Subway.	Surface.	Total.
Millions of passengers carried	127	210	337	646	*1,072	1,718
Persons killed	8	23	31	75	313	388
Population		1,480,000			4,250,000	

*7% of this mileage is horse cars, the remainder is electric.

DIESEL ENGINES INSTALLED IN THE UNITED States now number 162, aggregating 30,240 HP., according to a paper on the progress of the Diesel engine, read by Col. E. D. Meier, of New York City, at the meeting of the National Association of Cotton Manufacturers last week. The larger size American Diesel engines convert over 30% of the theoretical heat units in the fuel supplied, into mechanical work. The engines are guaranteed to use not more than 8 gals. of fuel oil per 100 HP.-hrs., running at any capacity between full rating and half load. In actual duty trials on the company's testing beds, engines of 225 HP. have shown an average consumption of only 5.78 gals. per 100 HP.-hrs.

DIESEL ENGINES FOR MARINE USE, and also for use on railway locomotives, are being introduced in Europe and were described in the above paper as follows:

Marine Diesel engines have been successfully developed in Russia mainly for oil tank vessels, in France for submarine boats, in Switzerland for passenger boats, yachts, and naval tenders, and in Sweden for auxiliary power for schooners. Last summer the French submarine fleet, all Diesel vessels varying in power 400 to 900 HP., made a run from Brest via Cherbourg to Dunkirk and back, a distance of 750 nautical miles, and delivered its successful attack on the battleships in Brest Harbor at the end of the run. French naval designers are now planning submarines each equipped with 1,400 HP. in Diesel engines. The Diesel engine makes these vessels formidable agencies for attack on the high seas.

In Switzerland, on Lake Zurich, a small passenger steamer was last summer converted into a Diesel boat under the following conditions. The vessel steamed at best speed 8¾ miles per hour, while 11¼ miles was demanded. The Diesel equipment must not require more space or weight than the steam plant. This was accomplished with a saving of 35% in weight, a tenfold increase in fuel-carrying capacity, and a reduction of fuel cost to one-quarter that of the steam-engine.

Test runs over a 15-mile course showed a speed of 12½ miles per hour, fuel cost 3 cts. per mile, or 2.8 miles per net HP. The fuel used was Galician crude oil, at $11.50 per ton equivalent to 3.64 cts. per gal.; the results figure to 0.541-lb. per brake HP., or 27.8 cts. per 100 brake-HP. hrs. It is thus shown that by giving up a fraction of the marvelous economy of the original Diesel engine, adopting the two stroke, a much lighter engine can be constructed.

On this basis a 1,200-HP. express locomotive is being built for the Prussian State Railways, which is expected to be ready for tests late the coming summer.

In the marine engine and the locomotive the paramount consideration naturally was reduction of weight to a minimum. Therefore the two-cycle type of engine was chosen with full recognition of the fact that no two-cycle engine has ever reached the economic performance of the four-cycle engine of the same type.

A THREE-YEAR RECORD OF A DIESEL ENGINE plant at the municipal electric plant of Bellefontaine, Ohio, is printed in "Power and The Engineer" for April 19. As such a long and continuous record has not been published before we reprint a few of the most important figures noted. Two 225-HP. Diesel oil motors are each directly connected to one 150-KW., 2,300-volt, 60-cycle generator. Each generator drives by a belt a 15-KW., 150-volt exciter. The generators operate in parallel without trouble. The Diesel motors were guaranteed not to use more than 12.5 gals. of fuel oil per 100 KW.-hrs. at the switchboard running with a 50% load factor. It has been found that, running at three-quarters load, the engines are able to produce 100 KW.-hrs. at the switchboard with an oil consumption of 9.75 gals. One day and one night engineman are required at a total monthly expense of $175. No unskilled labor is required:

	May-Dec., 1906.	Jan.-Dec., 1907.	Jan.-Dec., 1908.	Jan.-May, 1909.
KW.-hrs. output	310,892	766,290	909,763	308,910
Gals. fuel oil	39,683	91,803	100,778	36,990
Gals. per KW.-hr.	0.13	0.12	0.11	0.12
Gals., crank-case oil	240	360	295	101
Total cost, fuel oil	$1,190.49	$2,754.09	$3,023.34	$1,109.70
Total cost, crank oil	69.60	87.00	85.55	29.29
Total cost, repairs	23.00	56.00	101.60	27.15
Total cost, attendance	1,345.00	2,100.00	2,100.00	755.00
Total operat'g costs	$2,628.09	$4,997.09	$5,310.49	$1,921.14
Aver. load factors	32%	47%	56.6%	45%
Aver. cost per KW.-hr.	0.85 ct.	0.65 ct.	0.59 ct.	0.62 ct.
Average load factor for the entire three years				46.7%
Aver. operating costs per KW.-hr. for 3 years				0.65 ct.

MONTHLY SUMMARY OF RESULTS OF OPERATION OF THE PLAINFIELD SEWAGE PURIFICATION WORKS, 1909.

Month, 1909.	Sewage, million gallons daily.	Suspended matter, parts per million.				Oxygen consumed, parts per million.				Nitrogen as Nitrites and Nitrates. parts per million.		Putrescibility.		Bacteria, Millions per c.c.				% Removed.	
		Screened sewage.	Septic Effl.	Primary Effl.	Secondary Effl.	Screened sewage.	Septic Effl.	Primary Effl.	Secondary Effl.	Primary Effl.	Secondary Effl.	Primary Effl.	Secondary Effl.	Screened sewage.	Septic Effl.	Primary Effl.	Secondary Effl.	By filters only.	By entire system.
Jan.	1.6	110	48	19	9	89	55	24	11	0.9	3.6	+	0	2.49	1.09	0.50	0.27	75	89
Feb.	1.6	104	56	18	8	87	53	22	10	1.2	3.9	+	0	1.89	0.87	0.34	0.21	76	89
March	1.7	102	58	12	7	81	54	19	10	1.2	4.1	+	0	2.02	0.92	0.30	0.18	80	91
April	1.7	122	46	11	8	76	46	19	10	0.5	4.7	+	0	2.43	1.63	0.52	0.33	80	87
May	1.6	164	39	18	9	75	45	21	10	0.2	3.2	+	0	2.22	1.16	0.49	0.32	72	85
June	1.7	126	57	24	14	64	47	23	13	0.2	2.3	+	0	2.21	0.97	0.25	0.21	78	90
July	1.7	126	67	19	11	58	48	20	10	0.4	3.7	+	0	1.92	1.24	0.33	0.23	81	88
Aug.	1.6	166	55	23	9	62	45	20	9	0.4	3.8	+	0	2.09	0.98	0.31	0.18	82	91
Sept.	1.6	132	39	22	8	66	45	22	9	0.6	3.5	+	0	2.47	1.03	0.50	0.36	65	85
Oct.	1.6	145	50	28	10	67	49	25	10	0.5	3.0	+	0	2.47	0.86	0.49	0.25	71	86
Nov.	1.6	179	57	30	16	84	57	33	15	0.9	3.3	+	?	2.13	0.75	0.46	0.25	66	88
Dec.	1.7	135	57	31	13	82	58	28	12	0.8	4.0	+	0	2.43	0.81	0.42	0.24	70	90
Average	1.6	134	52	21	10	74	50	23	11	0.6	3.6	+	0	2.23	1.03	0.46	0.25	76	89

A HEAVY FALL OF ROOF in the Camelia mine near Pachuca, Mexico, April 23, killed seven miners. The fall is reported to have involved 200 tons of rock.

A hoisting machinery break-down, April 27, at the Tyny-Bodu colliery in Wales imprisoned 500 men in the mine for several hours.

THE BOILER OF A DREDGE exploded May 2 in Newark Bay. The dredge sank and one man of its crew was killed. The dredge was "No. 5" of the Newark Bay Improvement Co. and had been recently overhauled and put, presumably, in good condition.

A DYNAMITE LIGHTER EXPLODED April 7 in Kobe Harbor, Japan. The lighter, loaded with 130 tons of dynamite, was seen to be on fire in time to allow several nearby steamers to reach a safe distance. Two other dynamite lighters, holding 50 tons more, were sunk by the upheaval without exploding. The two men on the exploded lighter were killed and scarcely a house in Kobe escaped some damage.

AN EXPLOSION IN THE GARBAGE DIGESTING plant on Barren Island, Jamaica Bay, Long Island, April 30 unroofed one of the buildings, killed one laborer and severely injured five others. The explosion occurred in one of the digesters, a vertical cylinder made of boiler plate in which garbage is cooked by direct application of steam for several hours. The recording steam gage is reported to have showed a pressure of 65 lbs. in the digester when the explosion took place. The initial failure occurred in the cylindrical wall of the digester which was presumably weakened by corrosion.

The garbage disposal works on Barren Island are owned and operated by the New York Sanitary Utilization Co. and consumes practically all the garbage of Greater New York. A full description of the plant was published in Engineering News, Feb. 1, 1900. The plant was destroyed by fire May 20, 1906, but has since been rebuilt with practically the same equipment.

A HOTEL FIRE AT CORNWALL, ONT., April 29 caused the death of twelve persons, eight of whom were guests. Sixty persons were asleep in the three upper stories of the hotel when the fire was discovered at an early hour in the morning. The fire started on the main stairway and the only remaining means of egress from the upper floors was by rope fire-escapes. The hotel, the Rossmore, was built 20 years ago. It was entirely destroyed together with several adjoining buildings.

AN OIL RESERVOIR FIRE NEAR SAN PABLO, CAL., started April 21, shortly after midnight, in a large concrete reservoir owned by the Standard Oil Co. The tank was 150 ft. in diameter and contained, when the fire started, about 300,000 bbls. of oil. Unsuccessful efforts were made to extinguish the flames with chemical solutions. After 17 hours, it was estimated that only about 18 ins. depth of oil had been consumed.

On the night of April 21, with a dull explosion, the flaming oil poured over the sides of the reservoir and spread over the surrounding country. Trenches which had been hastily dug in preparation for just such a contingency proved entirely inadequate to confine the oil. The oil spread along the Atchison, Topeka & Santa Fe Ry. tracks, according to reports, from San Pablo to Sobrante, a distance of about five miles. The Santa Fe's tracks and telegraph poles were damaged sufficiently to stop all traffic over that section. The railway embankments and ditches saved the nearly parallel Southern Pacific tracks just beyond.

Nearly all of the oil in the tank was expelled by the explosion, which is ascribed to the boiling of the water collected in the bottom of the reservoir.

FIRE WRECKED A DRAWBRIDGE ENGINE-ROOM at Boston, Mass., on April 29. The Charlestown Bridge over the Charles River, which is a short distance northeast of the North Station and carries the rapid-transit elevated railway to Charlestown (Sullivan Square), was just to be opened for passing a tow when the draw-tender noticed flames in or under the engine-room. The engine-room is under the floor of the bridge at the turntable. The fire spread rapidly, and the oil accumulators used for operating the bridge became involved, one of them exploding. The fire was controlled before it could damage anything more than the engine-room equipment, but this latter appears to have been wrecked quite thoroughly. It will be necessary to operate the draw by hand for some time to come. The fire is attributed to the electric wiring connected with the pump motors. The loss is said to exceed $10,000.

THE 75TH ANNIVERSARY OF A RAILROAD CORporation was celebrated April 22 by the directors and officers of the Long Island R. R. The Board of Directors of that corporation held its first meeting 75 years ago. The officers of the present Long Island R. R., including the chief officers of the Pennsylvania R. R. System, of which it is now a part, spent the day in a trip over the Long Island lines.

A FLIGHT FROM LONDON TO MANCHESTER, ENGland, was made on April 27 and 28 by Louis Paulhan, the well-known French aviator. The flight was made for a prize of $50,000 offered by Lord Northcliffe, owner of the London "Daily Mail," to the first man to fly an aeroplane from London to Manchester, making no more than two stops. One, Grahame White, an Englishman, made two attempts to win the prize, once on April 23-24 and again on April 27, but being unable to cope with the winds encountered was forced to descend each time. Paulhan's first stage, from Hendon, London, to Litchfield, a distance of 117 miles, was made in 2 hrs. 50 min. The second stage of 68 miles was covered in 1 hr. 23 min., according to cabled reports. Paulhan used a Farman type of biplane.

Lord Northcliffe has now offered a prize of $50,000 to the British aeronaut who makes an aeroplane flight from London to Edinburgh and return.

ARCHITECT HUSTON WAS FOUND GUILTY of conspiracy to defraud the State of Pennsylvania in the Capitol contracts, by a jury at Harrisburg on April 29. The jury was out 26 hrs., and at one time wanted to bring in a verdict holding him guilty of the attempt to defraud but innocent of conspiracy; this verdict being not in accord with the indictment, however, they were sent back by Judge Kunkel, and ultimately convicted according to the indictment, with however a recommendation for leniency. Joseph M. Huston was the architect for the Pennsylvania State Capitol, and in that capacity, it is alleged, approved flagrant overcharges. The contractors, the State treasurer, and others were indicted with Huston for these frauds. Some of the defendants have already been convicted, several died, and Huston is the last of the gang to get justice. A feature of his trial was the testimony of four or five other architects to exculpate him. They testified that the architect's approval of a certificate or progress estimate is purely formal as to amounts, his signature really meaning nothing more than that the quality of the materials or work concerned was satisfactory; and that the certification of quantities is the sole duty of a sub-employee, the "clerk of the works." This ingenious defense did not prevail, however. The judge charged the jury that the testimony of the architects was of small importance in comparison with the defendant's acts, and that both Huston's duty and his performance must be judged from his acts.

The conviction of four members of the Capitol graft ring was obtained in March, 1908; a second trial, on another element of the frauds, resulted in acquittal (Eng. News, March 19, and June 18, 1908).

THE LUMSDEN INVESTIGATION COMMITTEE made its report to the Canadian Parliament on April 28. This committee was appointed to investigate charges brought by Mr. Hugh Lumsden (former Chief Engineer of the Grand Trunk Pacific Railway Commission, and Past President of the Canadian Society of Civil Engineers), that earth and rock had been improperly classified in the payment of contractors for work done on the Grand Trunk Pacific Ry. The following extracts from the Committee's report are taken from the Toronto "Globe" of April 29:

The report of the committee is summed up in the following words:

Your committee beg to submit the evidence and to report that, in our opinion, Mr. Lumsden's charge of general disregard of his instructions has not been sustained, and no evidence has been adduced which, in our opinion, would justify him in stating that he had lost confidence in the portion of the engineering staff referred to by him.

Mr. Lumsden stated that he had appeared only as a witness, and that he did not impute bad faith to any of the engineers, and that the issue was simply a difference between engineers as to classification. The report states that the evidence, especially that of Mr. Lumsden himself, shows that the substantial reason for the difference between Mr. Lumsden and the engineers under him arose through different interpretations of the specifications sent out by Mr. Lumsden on which the classification of solid rock, loose rock, and common excavation was to be made.

This difference of opinion as to the interpretation of Mr. Lumsden's specification developed at a very early stage of the construction, especially in connection with the classification of the peculiar geological formation met with in very large quantities upon portions of districts "F" and "B," consisting of clusters of boulders of varying sizes solidly cemented together in masses, which, according to the absolute consensus of testimony (including that of Mr. Lumsden), could not be removed except by continuous blasting. The resident engineers, to whom the duty of classification as the work proceeds is committed, returned this material as solid rock, and in this had the approval of their immediate superiors, the division and district engineers. While Mr. Lumsden stated in his evidence that he was dissatisfied with this classification, he continued approving and certifying the monthly estimates based upon this classification until October, 1907, when Assistant Chief Engineer Woods of the G. T. P. filed a complaint that there was over-classification of material in district "B."

The evidence of Mr. Lumsden himself shows that no engineer was appointed by the commissioners except upon the recommendation of Mr. Lumsden. There has not been in the whole course of the inquiry a suggestion that the appointment of any engineer was imposed upon Mr. Lumsden, or that the commissioners ever declined to give effect to any recommendation of Mr. Lumsden for the dismissal of any engineer.

Dealing with the question of the increased cost of the road over the preliminary estimates, the report notes that the preliminary estimates were necessarily based on preliminary survey lines, which were in many cases subsequently very materially changed. Mr. Lumsden himself stated that even the final location was in many cases changed, and this would account for a great deal of difference in cost. The final estimate of $114,000,000, compiled by Mr. Lumsden from the reports of his assistant engineer, was, as appears by the evidence, incomplete, but, as was stated by Chief Engineer Grant, there will be no great difference between the actual cost and the $114,000,000 estimate, exclusive of terminal and other items, which were not included in the estimate. The whole question of over-classification Mr. Grant characterized as a "tempest in a teapot."

In conclusion the committee says:

It is to be regretted that Mr. Lumsden did not go earlier upon the work himself and visit it more frequently. Had he done so it is possible that any question arising in regard to classification would have been immediately and satisfactorily adjusted, and when any difference arose your committee are of the opinion that it was Mr. Lumsden's duty as chief engineer to have immediately taken steps to have had the difference settled, and if any portion of the staff refused to conform to his instructions, to have recommended their dismissal to the Board of Commissioners. The district engineers, Mr. Doucet and Mr. Poulin, both engineers of large experience and of high standing in their profession, stated that they were thoroughly familiar with the classification returned from their respective districts, and expressed their complete satisfaction with the engineers under them, and assumed complete responsibility for the work in their districts.

The report is signed by Messrs. Geoffrion, Macdonald, Wilson and Clarke, the four Liberal members of the committee, who heard the evidence after the default of the Conservative members, Messrs. Lennox, Barker and Crothers.

ABOUT 5,500 ACRES OF LAND have been bought by Atlantic City, N. J., to protect and control its water-supply. This includes nearly the whole drainage area of Absecon Creek above salt water. About $150,000 was paid for the land. It is expected that some 500 acres more will be bought. There is a possibility that a part of the area purchased may be turned over to the State Forestry Commission. Mr. Lincoln Van Gilder is Superintendent of Water-Works.

THE TORONTO MUNICIPAL ELECTRIC WORKS are nearly completed, it is reported. The present street-lighting contract will run until Dec. 30, at which time it is expected the entire municipal electric works will be completed. The system, when done, will have cost about $2,750,000, and will include five substations and an underground distributing system. Some 7,600 HP. of energy will be taken from the line of the Hydro-Electric Commission of Ontario, now being built from Niagara Falls; of this about 3,000 HP. will be used for street lighting, about 4,000 HP. for the water-works and some 600 HP. for miscellaneous purposes.

ELECTRIC POWER SYSTEMS IN MEXICO.—The state of Chihuahua, it is reported, has granted a concession, for the establishment of ten light and power systems in that state, to the Mexican Securities Corporation of Halifax, N. S. This concern is allied with the Mexican Northern Power Co., also a Canadian corporation, which is constructing a large hydro-electric plant on the Conchos River.

The state of Durango has also granted a concession to one Francisco Neugebaurer for the construction of either an electric or steam railway from Tepehuanes to the Guanacevi mining district. The state donates right-of-way and terminal grounds and guarantees 6% interest for 25 years on any capital expended. The type and equipment of the line have not yet been fixed.

THE BUFFALO WATER-WORKS INTAKE TUNNEL was holed through at 8 a. m., May 1, 1910, at a point 6,360 ft. out from the shore shaft (Porter Ave. shaft) and 250 ft. inshore of the intake crib. The tunnel is in hard limestone rock and black flint, and practically the whole of its length was driven with the protection of compressed air (25 to 28 lbs.), as the rock has many seams. The tunnel is 12 ft. wide by 11 ft. 3 ins. high inside the concrete lining, or 15 ft. by 14 ft. 9 ins. over all. Excavation was carried on by top heading, keeping the bench 25 to 50 ft. back of the face. Lining was carried on at the same rate as excavation, being kept 300 to 500 ft. back of the heading.

The intake crib and the shaft in it were completed in September, 1909. A bulkhead was built in the shaft, and 250 ft. of tunnel were driven landward (but without com-

pressed air). All the remainder of the tunnel was driven from the Porter Ave. land shaft, where air was put on after the first 400 ft. Three-shift working was started Nov. 1, 1909, and since then the average progress of the tunnel excavation and lining has been 90 to 96 ft. per week of 6 working days. Before Nov. 1, with two shifts, 60 to 66 ft. per week had been made. The greatest month's progress was achieved in March, 1910, with a progress of 390 ft. in 25 working days (2 days lost), making an average progress of nearly 16 ft. per day or over 5 ft. per shift. The schedule of working required each shift to muck out, set up, drill and shoot. The work of the heading gang was considerably retarded, however, by the concreting gangs.

It is expected that the work will be finally completed in July or August, 1910, which will be about a year ahead of the contract time. The work is being done by the Buffalo Dredging Co., and Mr. C. H. Hollingsworth, Superintendent of Tunnel Construction for that company, is our authority for the above data.

The land tunnel connecting the Porter Ave. shaft with a shaft at Front Ave. near the water-works, was holed through in April, 1909. This is of smaller section, 9 ft. by 7 ft. inside or 12 ft. by 10 ft. over all. It lies in moderately hard limestone.

The new intake system is being constructed under the Department of Public Works of the city of Buffalo (Col. F. G. Ward is Commissioner of Public Works). Mr. S. J. Fields is Engineer in charge of water-works construction.

BONDS FOR SELF-SUPPORTING MUNICIPAL UNdertakings in New York State were exempted from the constitutional limitation upon the bonded debt which a city may incur, by a law passed in the New York Legislature on May 2. This law carries into effect a constitutional amendment accepted at the last general election in the state. Its purpose is to give New York City more available funds, primarily for needed subway construction, now hampered by the fact that the total of the city's bonded indebtedness is near the constitutional limit of percentage of the assessed valuation. As a large part of the dock investments and the first subway are paying investments, i. e., self-supporting, it was held that these should not be counted in computing the total of bonds as regards the constitutional limitation. After several years of agitation this view finally found expression in an explanatory amendment to the State Constitution, and now in a specific law.

Personals.

Mr. Arthur H. Blanchard, M. Am. Soc. C. E., has been elected a member of the Société des Ingénieurs Civils de France.

Mr. Carl Berger has resigned his position as Superintendent of the Bureau of Buildings in the Borough of Queens, New York City.

Dr. Charles S. Howe, President of the Case School of Applied Science, will deliver an address before the graduating class of the Missouri School of Mines at Rolla, Mo.

Mr. Chas. F. Wilson, formerly City Engineer of Ottawa, Ill., has recently removed to North Yakima, Wash., where he will open an office for general practice as a civil engineer.

Mr. W. I. Klein has resigned his position as Assistant Engineer on the improvement of the water-supply at Albany, N. Y., and has entered the service of the New York Continental Jewell Filtration Co., in Jersey City, N. J.

Mr. Winslow T. Perkins has resigned his position as Superintendent of the eastern division of the Boston & Maine R. R. and will retire from active work. He had been in the service of the Boston & Maine for nearly 20 years.

Mr. Jason Paige, Assoc. M. Am. Soc. C. E., formerly Contracting Engineer of the Lackawanna Bridge Co., with office in New York, is now with the Sales Department of the Interocean Steel Co., Railway Exchange Building, Chicago.

Mr. Benjamin Herman Davis, Assoc. M. Am. Soc. C. E., Engineer of Concrete Structures, Delaware, Lackawanna & Western R. R., has left that position and has opened offices as a consulting engineer at 1 Madison Ave., New York City.

Mr. Chas. F. Breitzke, Jun. Am. Soc. C. E., has resigned his position as Assistant Engineer, New York State Department of Health, and has removed from Albany to New Paltz, N. Y., where he will take up the position of Assistant Engineer of the New York Board of Water Supply.

Mr. Edgar H. Wood, formerly Assistant Professor of Machine Design at Cornell University, has been appointed Professor of Mechanics of Engineering. Mr. Howard D. Hess, M. Am. Soc. M. E., formerly Assistant Professor of Machine Design at Cornell, has been made Professor of Machine Design.

Mr. J. B. Comstock, Manager of the publication department of the Westinghouse Electric & Manufacturing Co., at East Pittsburg, Pa., for the past four years, has left that position to take a similar one with the P. & F. Corbin Co., of New Britain, Conn. Mr. Comstock was in the employ of the Corbin company before entering the Westinghouse service six years ago.

Mr. R. B. Owens, M. Am. Inst. E. E., has been appointed Secretary of the Franklin Institute, Philadelphia, Pa., to succeed Mr. James Christie, resigned. Mr. Owens was Professor of Electrical Engineering at the University of Nebraska in 1891-98, and held a similar position at McGill University from 1898 until 1909, when he joined the engineering staff of the Southern Power Co.

Mr. J. Paul Jones Williams, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer Designer with the McClintic Marshall Construction Co. at Swissvale, Pa., has been appointed Assistant Professor of Civil Engineering at Columbia University. Mr. Walter Irvine Schlichter, formerly with the General Electric Co. at Schenectady, N. Y., has been appointed Professor of Electrical Engineering at Columbia.

Mr. Morton G. Lloyd, Assoc. Am. Inst. E. E., has become Technical Editor of the "Electrical Review and Western Electrician." He is a graduate of the course in electrical engineering at the University of Pennsylvania and pursued post graduate studies for three years at Pennsylvania, Harvard and Berlin. Since 1902 he has been employed in the U. S. Bureau of Standards at Washington, D. C. His last office in the Bureau was that of Associate Physicist in charge of magnetic testing.

Mr. Ray Morris, who since 1903 has been Managing Editor of the "Railway Gazette" (now the "Railway Age Gazette") has resigned his position to become a partner in the banking house of White, Weld & Co., of New York City. Mr. Morris is a brother-in-law of President Hadley, of Yale University, and his connection with the "Gazette" was an outgrowth of Prof. Hadley's work in the '90's as an editorial writer for that publication. During his connection with the "Gazette," Mr. Morris has also been a contributor to other important publications, and has given special attention to matters of railway finance. It is this, probably, which has led him to his new connection.

Mr. Harry R. Safford, M. Am. Soc. C. E., has resigned his position as Chief Engineer of Maintenance of Way of the Illinois Central R. R. and will become Vice-President of Edgar O. Allen & Co., of Sheffield, England. The position of Chief Engineer of Maintenance of Way has been abolished on the Illinois Central and Mr. Lewis W. Baldwin has been appointed Engineer of Maintenance of Way. Mr. Lawrence A. Downs, formerly Assistant to the Chief Engineer of Maintenance of Way, has been made Assistant Engineer of Maintenance of Way. Mr. Daniel J. Brumley, M. Am. Soc. C. E., formerly Principal Assistant Engineer, has been made Engineer of Construction. The departments of maintenance of way and construction have been combined under Chief Engineer A. S. Baldwin, M. Am. Soc. C. E.

Dr. Rossiter W. Raymond, Past-President Am. Inst. M. E., was given a banquet at the Plaza Hotel in New York City on the evening of April 30 in celebration of his 70th birthday, April 27. For 26 years, Dr. Raymond has been Secretary of the American Institute of Mining Engineers and the celebration was arranged partly in appreciation of his services in this capacity.

Dr. James Douglas, Past-President, Am. Inst. M. E., was the toastmaster. Mr. E. G. Spilsbury, Past-President, Am. Inst. M. E., read a few of the many messages of congratulation. Mr. R. T. Bayliss, Vice-President, of the Institution of Mining and Metallurgy of Great Britain, after remarking that he had crossed the Atlantic solely for the purpose of attending the dinner, read a set of resolutions adopted by the Institution of Mining and Metallurgy and in conclusion presented to Dr. Raymond the Gold Medal of the Institution. This medal is the highest honor the society can award and Dr. Raymond is the seventh one to receive it since the first award in 1902.

Mr. Julio-Frederico Sorzano de Tejada, Member of the Société des Ingenieurs Civils de France, read congratulatory resolutions adopted by that society. Dr. Frank Adams, President of the Canadian Mining Institute; Dr. Lyman Abbott, and Mr. George Westinghouse, President, Am. Soc. M. E., were others who spoke.

Dr. Raymond was accompanied by Mrs. Raymond, to whom he gave credit for her part in his work when he arose to express his appreciation, and by his sister, Miss Susie Raymond. Other prominent persons present were Mr. John Fritz, Past-President Am. Inst. M. E. and Am. Soc. M. E.; Capt. and Mrs. Robert W. Hunt; Mr. W. L. Saunders, M. Am. Inst. M. E.; Mr. Thomas C. Martin, and Mr. John A. Bensel, President, Am. Soc. C. E. The banquet was concluded by the presentation to Dr. Raymond of a handsome silver service.

Obituary.

Chas. Lyon McIntosh, Treasurer of the I. I. Case Threshing Machine Co., died April 19 at Naples, Italy.

John I. Kinsey, who was for 40 years Master Mechanic of the Lehigh Valley R. R. shops at Easton, Pa., died at that place April 28, aged 83 years. Mr. Kinsey retired from active work 12 years ago.

Frederick Gwinner, a prominent contractor of Pittsburg, Pa., died April 27 at his home in that city from pneumonia. Mr. Gwinner was born in Pittsburg in 1856 and was a graduate of the Western University of Pennsylvania in the school of engineering. He was admitted as a partner in his father's contracting business at the age of 21. At the time of his death Mr. Gwinner was President of the Allegheny Traction Co., the National Fireproofing Co. and of other concerns in Pittsburg.

George Bell Reeve, former Vice-President and General Manager of the Grand Trunk Ry., died May 1 at his home in Lamirada, Cal. Mr. Reeve was born in Surrey Co., England, in 1840. He entered the service of the Grand Trunk in 1860 as a freight clerk. He was made General Traffic Manager in April, 1900, and in December of the same year became Second Vice-President and General Manager. He retired in January, 1902, since when he has resided on his ranch in Lamirada, Cal.

Ernest P. Sparrow, M. Am. Soc. M. E., died April 18 at Boston, Mass. He was born at Greenville, Me., in 1857, and was a graduate of the Worcester Polytechnic Institute. He had a most varied early experience, largely in erecting work, with a number of different companies. In 1893-96 he was Erecting Superintendent of the E. P. Allis Co. He was subsequently Master Mechanic of the Boston Rubber Shoe Co. and, for a short time, was in the employ of Browne & Sharpe. For some years before his death, Mr. Sparrow was engaged upon special engineering work for the B. F. Sturtevant Co.

Edward P. Alexander, formerly a second lieutenant in the Corps of Engineers, U. S. Army, died April 28 at Savannah, Ga., aged 75 years. Mr. Alexander was born in Washington, Ga. He was graduated at West Point in the class of 1857 and served until 1861 with the rank of Second Lieutenant in the Corps of Engineers. In the last-named year he resigned to enter the Confederate army as a Captain in the engineer corps. During the Civil War he rose to the rank of Brigadier General of Artillery. He was a Government director of the Union Pacific R. R. in 1885-7 and in 1892-4 was a member of various river and harbor boards.

Franklin Wilson Hart, formerly an engineer in the service of the Isthmian Canal Commission, died recently at Washington, D. C. Mr. Hart was born in Washington 37 years ago and graduated at the high school of that city in 1890, subsequently studying civil engineering at the Columbian University. He entered the service of the District Government in 1891 and became an assistant engineer in the Department of Highways. He resigned this position at the outbreak of the Spanish-American War and was made a paymaster in the U. S. Navy. He resigned from the Navy after seven years' service to re-enter the field of civil engineering. He entered the service of the Isthmian Canal Commission in 1906. His work on the Isthmus included the laying out of streets and superintending construction of drainage systems and reservoirs at Cristobal, Gatun and other points along the canal.

Rear-Admiral Philip Hichborn, U. S. N., retired, died May 1 at his home in Washington, D. C. He was born in Charlestown, Mass., in 1839 and was a graduate of the high school of that city. He began his career as an apprentice in the Charlestown Navy Yard, where he completed his term of apprenticeship in 1859. He was recommended for an advanced course in mathematics and developed in this course marked ability. After entering the Navy he rose rapidly through the various grades to the position of Naval Constructor, which he attained in 1875, being at that time at the Portsmouth Navy Yard. In November, 1884, he was made Assistant to the Chief of the Bureau of Construction and Repair at Washington, D. C. He became Chief Naval Constructor in July, 1893, with the rank of Commodore, and was advanced to the rank of Rear-Admiral in 1897. He was retired in 1901. During his long service Rear-Admiral Hichborn designed a total of about 150 vessels for the Navy and devised many original improvements in naval construction and navy yard management.

John H. Converse, President of the Baldwin Locomotive Works, died on May 2 at his home in Philadelphia, after a brief illness from heart disease. Mr. Converse was born in Burlington, Vt., Dec. 2, 1840, and was the son of a clergyman, Rev. John Kendrick Converse. He was educated in the schools of his native town and at the University of Vermont, from which he graduated in the class of 1861. For three years after graduation Mr. Converse was engaged in journalism on the staff of the Burlington "Times." In 1864 he went to Chicago and obtained a position in the General Manager's office of the Chicago & Northwestern Ry. Co. After two years he removed to Altoona, as an assistant to Edward H. Williams, then General Superintendent of the Pennsylvania R. R. In 1870 Mr. Williams, who had been in railway service since 1850, purchased an interest in the Baldwin Locomotive Works, of Philadelphia, and Mr. Converse went there with him. After three years' work there, Mr. Converse had become such an important and valuable factor in the business that he was admitted to